NATIONAL COOPERATIVE SOIL SURVEY

Soil Survey Conference Proceedings

San Antonio, Texas
January 29 - February 2, 1979

Proceedings of -----

NATIONAL **TECHNICAL WORK-PLANNING** CONFERENCE
OF THE
COOPERATIVE **SOIL** SURVEY

San Antonio, Texas

January 29 - February 2, 1979

REPRODUCED BY

Soil Conservation Service
United States Department of Agriculture

SUMMARY

NATIONAL TECHNICAL WORK PLANNING CONFERENCE

The format for the National Technical Work Planning Conference in San Antonio, January 29 to February 2, 1979, “as changed from recent previous conferences. More time “as allotted at the conference for participants to discuss committee issues. Each committee had two separate sessions totaling about 6 hours. This resulted in more meaningful and worthwhile inputs.

As a result of travel budget restraints and bad weather, overall attendance at the conference “as not as large as some previous conferences. However, there “as a good cross section of professional and agency interests as well as representatives of foreign countries. This and the fact that the committees did very well identifying and evaluating issues that are important to the NCSS stimulated lively discussions. Overall, the results were very satisfactory.

The complexity and importance of the issues to be resolved by three of the committees are such that additional time is required for further assessment and development of recommendations. The following committees “ill remain active until the next conference in 1981:

- Surface Horizon Characteristics under Different Conditions
  Chairman - Dr. W. E. Larson, SEA

- Water Supplying Capacity of Soils for Different Plants
  Chairman - Dr. R. B. Grossman, SCS

- Confidence Limits for Soil Survey Information
  Cochairman - Dr. L. P. Wilding, Texas A&M University
  Dr. F. P. Miller, University of Maryland

Although the assignments to these committees have been continued, ideas and suggestions from others would be most welcome. Send them to the appropriate committee chairman.

Recommendations for long-range objectives of the NCSS (Committee #1) will be used for policy guidance and will be considered for revisions of the National Soils Handbook.

The use of soil family class (Committee #2) in soil surveys “a8 evaluated and it “as determined that for some purposes they can be used effectively. The essential factor in the use of soil family class is the ability to transfer information. It is believed that phases of families can be correlated and interpreted for meaningful uses if the interpretations are readily distinguishable from phases of soil series information. This is yet to be tested. SOILS-5 and SOILS-6 can be adapted to this use. If series and family level data can be identified, processed, and used without losing their distinction, then the family data can be stored and transferred. The West Technical Service Center Soils Staff has been given responsibility for developing and testing the procedures. If it is feasible, the National Soils Handbook will be revised as needed.

The work of the committee on soil-water relations (Committee #6) has been incorporated into the current draft revision of Chapter 5, Soil Survey Manual. This draft is now being reviewed. After this review is completed a general distribution of this chapter is planned for the Fall of 1979.

A sincere thank you is extended to all who helped make the National Technical Work Planning Conference in San Antonio a success. The contributions from the staff in Texas who gave local support, the members of the committees, and all the participants are greatly appreciated.

KLAUS W. FLACH

TOUR SCHEDULE
Wednesday, January 31, 1979

LV:	Menger Hotel PROMPTLY at	12 noon
AR:	Camp Bullis Headquarters	12:30
	LUNCH	
LV:	Camp Bullis Headquarters	1:05
AR:	Site 1 - Edwards Recharge Structure	1:15
	Discussion: Mr. Dusty Bruns, Range and Wildlife Management Specialist, Department of Army, Camp Bullis Dr. Weldon Hammond, Geologist, University of Texas, San Antonio	
LV:	Site 1	1:45
AR:	Fair Oaks Subdivision	2:25
	Stop - Road Cut - Soil Discussion	
LV:	Fair Oaks	2:45
AR:	Verstraeten Farm	3:30
LV:	Verstraeten Farm	3:45
AR:	Buckhorn Museum	4:00
LV:	Buckhorn Museum	5:00
AR:	Menger Hotel	5:30

Tour Guides: Erwin Willard, District Conservationist, SCS, San Antonio

Pete Saenz, Range Conservationist, SCS, San Antonio

Bill Dittmore, Soil Scientist, Fredericksburg

TABLE OF CONTENTS

AGENDA

NATIONAL TECHNICAL WORK PLANNING CONFERENCE
OF THE
NATIONAL COOPERATIVE SOIL SURVEY

January 29 - February 2, 1979

San Antonio, Texas

MONDAY

8:30 - 8:50 a.m.	"The Heritage We Guard"	C. A. Fountain
8:50 - 9:oo a.m.	Introduction and Announcements	
9:oo - 11:45 a.m.	Meetings	
Committee #1	Long Range Objectives of the National Cooperative Soil Survey	Joe D. Nichols
Committee #3	Surface Horizon Characteristics Under Different Conditions	W. E. Larson
Committee #5	Confidence Limits for Soil Survey Information	L. P. Wilding and F. P. Miller
11:45 - l:oo p.m.	Lunch	
	GENERAL SESSION	Daniel E. Holmes
l:oo - 1:30 p.m.	Dr. J. E. Miller President, Texas A&M University	
1:30 - 2:oo p.m.	Mr. R. M. Davis Administrator, Soil Conservation Service	
2:oo - 2:20 p.m.	Dr. Klaus W. Flach Assistant Administrator for Soil Survey	
2:20 - 2:45 p.m.	BREAK	
2:45 - 4:05 p.m.	Regional Work Planning Reports Northeastern Southern North Central Western	Klaus W. Flach

4:05 - 4:25 p.m.	Report - Canada	
4:25 - 4:45 p.m.	Report - Mexico	
8:30 p.m.	GENERAL SESSION (Other Federal Agencies)	J. M. Williams

TUESDAY

8:00 - 12:00 M	Meetings	
Committee #2	Use of Soil Family Class in Design of Map Units	J. E. Brown
Committee #4	Water Supplying Capacity of Soils for Different Plants	R. B. Grossman
Committee #6	Review and Test Soil Water Section of the Revised Soil Survey Manual	Maurice Stout, Jr.
12:00 - 1:00 p.m.	Lunch	
1:00 - 5:00 p.m.	Meetings Committee #1 Committee #3 Committee #5	
8:30 p.m.	GENERAL SESSION (Non-USA Participants)	John D. Rourke

WEDNESDAY

8:00 - 11:30 a.m.	Meetings Committee #2 Committee #4 Committee #6	
12:00 - 5:00 p.m.	FIELD TOUR C. M. Thompson L. P. Wilding	

THURSDAY

8:00 - 12:00 M	GENERAL SESSION (25 minutes each)	Fenton Gray
	Internationalizing Soil Taxonomy	William M. Johnson
	Soil Survey Manual	Robert F. Mitchel
	Soil Taxonomy Problems, etc.	John E. McClelland
	Format for Published Soil Surveys	Donald E. McCormack
BREAK	Completing Soil Surveys Nationwide	Victor G. Link
	Soil Potential	Donald E. McCormack
	Public Participation	Ida Cuthbertson
	Soil Moisture Study Cadmium-Lead Study National Soil Survey Laboratory Services	Steven Holzhey
12:00 - 1:00 p.m.	Lunch	
1:00 - 5:00 p.m.	GENERAL SESSION (Reports)	K. W. Flach
1:00 - 1:50 p.m.	Committee #1	
1:50 - 2:40 p.m.	Committee #3	
2:40 - 3:10 p.m.	BREAK	
3:10 - 4:00 p.m.	Committee #5	
4:00 - 4:50 p.m.	Committee #2	

FRIDAY

	GENERAL SESSION (Reports)	K. W. Flach
8:00 - 8:30 a.m.	Task Force - John E. McClelland	
8:30 - 9:00 a.m.	Task Force - Donald E. McCormack	

FRIDAY (Continued)

9:oo - 9:50 a.m.	Committee #4
9:50 - 10:20 a.m.	BREAK
10:20 - 11:10 a.m.	Committee #6
11:10 - 12:00 M	SUMMARY
12:oo M	ADJOURN

NATIONAL TECHNICAL SOIL SURVEY WORK
PLANNING CONFERENCE

January 29 - February 2, 1979

PARTICIPANTS

Peter E. Avers
U.S. Forest Service
Watershed and Minerals
1720 Peachtree Road, N.W., Suite 301
Atlanta, Georgia 30309

Donald L. Basinger
Assistant Director
South Technical Service Center
Soil Conservation Service
Ft. Worth, Texas 76501

J. E. Brown
Soil Correlator
West Technical Service Center
Soil Conservation Service
Portland, Oregon 97209

Shelby Brownfield
State Soil Scientist
Soil Conservation Service
Boise, Idaho 83702

Louie I.. Buller
Soil Correlator
Midwest Technical Service Center
Soil Conservation Service
Lincoln, Nebraska 68508

Jack Chugg
Bureau of Land Management
Denver Service Center
Denver, Colorado 80225

Edward J. Ciolkosz
Assistant Professor of Soil Genesis
The Pennsylvania State University
University Park, Pennsylvania 16802

Harold Cosper
Economics, Statistics, 6 Cooperative Service
Room 435, Federal Building
U.S. Courthouse
Lincoln, Nebraska 68508

James R. Culver
State Soil Scientist
Soil Conservation Service
Lincoln, Nebraska 68508

R. M. Davis
Administrator, SCS
P.O. Box 2890
Washington, D.C. 20013

Ida Cuthberteon
Coastal Zone Management for NE; Community Planning; Public Participation
Soil Conservation Service
Washington, D.C. 20013

LeRoy Daugherty
Department of Agronomy
Box 3Q
New Mexico State University
Las Cruces, New Mexico 88003

John Day
Head, Soil Survey Program
Institut de Recherche sur les Terres
Central Experimental Farm
Ferme Experimentale Centrale
Ottawa, Ontario
Kia 0C6

James DeMent
Lockheed Electronic Systems and Services Division
1830 NASA Road Al
Houston, Texas 77058

Leroy DeMoulin
Division of Watersheds
Bureau of Land Management
Building 50
Denver, Colorado 80225

Raymond Dideriksen
Director, Inventory and Monitoring Division
Soil Conservation Service
Washington, D.C. 20013

William J. Edmunds
Department of Agronomy
Virginia Polytechnical Institute
Blacksburg, Virginia 24061

Klaus W. Flach
Assistant Administrator for Soil Survey
Soil Conservation Service
P.O. Box 2890
Washington, D.C. 20013

R. Follett
Agricultural Research Service
Room 330-A
Administration Building
Beltsville, Maryland 20705

Carl B. Fountain
Deputy State Conservationist
Soil Conservation Service
Temple, Texas 76501

Westal W. Fuchs
Assistant Director, Soil Survey
Operations Division
Soil Conservation Service
P.O. Box 2890
Washington, D.C. 20013

Talbert Gerald
Soil Correlator
South Technical Service Center
Soil Conservation Service
Ft. Worth, Texas 76501

Charles B. Goudey
Leader, Soils 6 Geology Group
U.S. Forest Service
630 Sansome Street
San Francisco, California 94111

Fenton Gray
Department of Agronomy
Oklahoma State University
Stillwater, Oklahoma 74074

Robert B. Grossman
Soil Scientist
National Soil Survey Laboratory
Soil Conservation Service
Lincoln, Nebraska 68508

Oiva R. Harju
Code 1542
Bureau of Reclamation
P.O. "ox 25007
Denver, Colorado 80225

E. 1.. Harris
Dept. of Soil & Crop Sciences
Texas A&M University
College Station, Texas 77843

Daniel E. Holmes
Director, South Technical Service Center
Soil Conservation Service
Ft. Worth, Texas 76501

Steve Holzhey
Head, National Soil Survey Lab
Soil Conservation Service
Lincoln, Nebraska 68508

Theron Hutchings
State Soil Scientist
Soil Conservation Service
Salt Lake City, Utah 84138

William M. Johnson
Deputy Administrator for Technical Services
Soil Conservation Service
P.O. Box 2890
Washington, D.C. 20013

Leon W. Kimberlin
Chief Agronomist
Ecological Sciences & Technology Division
Soil Conservation Service
Washington, D.C. 20013

Kermit Larson
Waterahed Management
U.S. Forest Service
Washington, D.C. 20250

W. E. Larson
Soil & Water Management
Research Unit
201 Soil Science Building
University of Minnesota
1529 Gortner Avenue
St. Paul, Minnesota 55108

Gerhard B. Lee
Department of Soils
University of Wisconsin
Madison, Wisconsin 53706

Victor G. Link
Director, Soil Survey
Operations Division
Soil Conservation Service
P.O. Box 2890
Washington, D.C. 20013

Helaine Markewich
U.S. Geological Survey
Reston, Virginia 22092

John E. McClelland
Director, Soil Classification and
Correlation Division
Soil Conservation Service
P.O. Box 2890
Washington, D.C. 20013

Donald E. McCormack
Director, Soil Survey
Interpretations Division
Soil Conservation Service
P.O. Box 2890
Washington, D.C. 20013

Eilif Miller
Principal Soil Scientist
Cooperative State Research Center
Science and Education Administration
Washington, D.C. 20250

Fred P. Miller
Professor, Soil & Water Resources
University of Maryland
College Park, Maryland 20742

Jarvis Miller
Director of Experiment Station
Texas A&M University
College Station, Texas 77843

Robert F. Mitchel
Assistant Director, Soil Classification
and Correlation Division
Soil Conservation Service
P.O. Box 2890
Washington, D.C. 20013

Joe D. Nichols
Head, Soils Staff
South Technical Service Center
Soil Conservation Service
Ft. Worth, Texas 76501

A. Osman
The Arab Center for The Studies of
Arid Zones and Dry Lands
P.O. Box 2440
Damascus, Syria

Harold I. Owns
Agronomist 6 Soil Conservationist
Extension Service
Science and Education Administration
Washington, D.C. 20250

H. F. Perkins
Professor, Soil Fertility
Department of Agronomy
University of Georgia
Athens, Georgia 30602

Wayne Pettapiece
Agriculture Canada - Soil Survey
14605 - 118 Avenue
Edmonton, Alberta, Canada T5L 2M7

Richard A. Piper
Code 737
Bureau of Reclamation
P.O. Box 25007
Denver, Colorado SO225

John W. Putnum
Leader, Comprehensive Resource Inventory
and Evaluation System
ERS/USDA
1405 South Harrison Road
East Lansing, Michigan 48823

Larry F. Ratliff
State Soil Scientist
Soil Conservation Service
Auburn. Alabama 36830

E. M. Richlen
Regional Soil, Scientist
Soil, Air, and Water Staff Group
USDA - Forest Service
P.O. Box 7669
Missoula, Montana 59807

John D. Rourke
Head, Soils Staff
Northeast Technical Service Center
Soil Conservation Service
Broomall, Pennsylvania 19008

E. M. Rutledge
Assoc. Prof. of Soil Morphology
Department of Agronomy
University of Arkansas
Fayettsville, Arkansas 72701

Pierre Segalen
Office de la Recherche
Scientifique at Technique Outre-Mer
70-74 Route d'Aulnay
93140 Bondy
France

Maurice Stout, Jr.
Head, Soils Staff
Midwest Technical Service Center
Soil Conservation Service
Lincoln, Nebraska 68508

James R. Talbot
Engineering Division
Soil Conservation Service
P.O. Box 2890
Washington, D.C. 20013

Charles Thompson
State Soil Scientist
Soil Conservation Service
Temple, Texas 76501

Peter Veneman
Assistant Prof. of Soil Genesis,
Morphology and Classification
University of Massachusetts
Amherst, Massachusetts 01002

Earl E. Voss
State Soil Scientist
Soil Conservation Service
Champaign, Illinois 61820

J. R. D. Wall
British Embassy
Apartado 2350
San Salvador
El Salvador
Central America

G. J. W. Westerveld
Head, Soil Survey Division
Netherlands Soil Survey Institute
Wageningen
Strichting voor Bodemkartering
Staring Building
P. 0. Box 98, Wageningen
11, Marikeweg
The Netherlands

Lawrence P. Wilding
Department of Soil and Crop Sciences
Texas A&M University
College Station, Texas 77043

J Melvin Williams
Head, Soils Staff
West Technical Service Center
Soil Conservation Service
Portland, Oregon 97209

Keith Young
Assistant Director
Soil Survey Interpretations Division
Soil Conservation Service
P.O.Box 2890
Washington, D. C. 20013

NATIONAL TECHNICAL WORK PLANNING CONFERENCE
OF THE NATIONAL COOPERATIVE SOIL SURVEY
San Antonio, Texas
January 29 - February 2. 1979

The National Cooperative Soil Survey is important to USDA and to cooperative agencies and organizations, because it supplies information that is basic to all of our work and is basic to many decisions by people who own and manage land and water.

The National Cooperative Soil Survey has a reputation for reliable basic data--and it is becoming increasingly efficient at supplying better data faster--because it is truly a cooperative effort. The work of experiment stations and Federal research scientists provides a very necessary support for the national program. Other Federal and State agencies make a vital contribution to specific surveys or specific questions.

I am impressed with what all of you have accomplished together. Yet, we do need to discuss some ways of intensifying or redirecting our efforts.

Every year we applaud the number of acres mapped and the number of manuscripts published. We call for a printout and announce that the fieldwork will be completed by 1997. Yet, you and I know that we will never be able to close the cover , put the soil survey program on a shelf, and say, "Now that job's done."

To maintain the soil survey as a valuable tool, we will need to keep it current...we will need to shift emphasis and technique and format to meet new needs. We will need to help more technical and professional disciplines relate soils data to their body of knowledge. We will need to adjust to more changes more rapidly than ever before.

One obvious need is for new soil survey interpretations in response to a variety of domestic and international changes.

The cost of energy is going out of sight. Various forms of reduced tillage, what we call "conservation tillage", can cut the fanner's tractor fuel costs by more than 50 percent. It is now being used on more than 40 million acres of cropland--to save energy and to save soil, which it does even better. But conservation tillage is not a perfected art.

We need more information about tillage and its environmental effects. We need more knowledge of its adaptability to various soils, especially to the poorly drained soils that warm up slowly in spring. If we study the mechanics of conservation tillage in relation to soil properties, and help others understand them, we can help refine conservation tillage and expand its use more rapidly.

Energy is a hidden but very real cost in fertilizer manufacture and use. Farmers have increased their yields tremendously by applying more and more commercial fertilizers, made from petroleum. Yet the yield increases are leveling off, and we are coming to realize the economic and environmental effects or limitations of using high rates of fertilizer on unsuitable soils.

With soil survey information, farmers can tailor the timing and the amount of fertilizer to the kind of soil they farm. Farmers may be able to maintain or increase production and still cut back on the total amount of fertilizer, thus saving energy and money.

Americans are becoming more interested in saving their environment, too...in cleaning up our air and water. . .in conserving natural resources for the future. Congress affirmed that commitment by passing the Soil and Water Resources Conservation Act.

Administrator's speech presented at the National Technical Work Planning Conference of the National Cooperative Soil Survey, San Antonio, Texas, January 29 - February 2, 1979

Under RCA, SCS and other USDA agencies are appraising the Nation's soil, water, and related resources; developing an overall program to guide conservation efforts; and evaluating current strategies.

Soil surveys are a key to the nationwide appraisal, in deciding:

--Quality and quantity of resources;

--Capability and limitation of resources;

--Changes in resource status and condition because of past use or farming techniques; and

--Costs and benefits of alternative practices.

Soil survey facts will be a must in several other USDA emphases:

The identification and preservation of important farmland will get special attention from government at all levels.

Clean water will continue to be a major concern. Land users will have reliable information about soil characteristics as well as farming methods and conservation practices to fashion workable "best management practices" for Section 208 and the Rural Clean Water Program.

Reclamation of old or new mined land will require detailed soils information--

--To help decide if prime farmland should be mined, and if so to help the miner meet the strict reclamation standards;

--To determine what layers to stockpile before mining and how to respread them after mining;

--To help mining firms develop engineering plans; and

--To reclaim the old scars under the Rural Abandoned Mine Program.

Land-use 'shifts will continue to tax our ability to stay one jump ahead--and one jump ahead is where soil surveys have to be in fast-growing areas.

More people and industries are moving to the sunbelt--the south and southwest--to take advantage of warmer climate and lower cost of living. Sleepy rural towns are facing heavy development and doubled or eve" tripled populations. As we already know from other areas, growth strains natural resources, but wise use of soil surveys by local planners and regional and State planning agencies can help ease the transition, its costs and effects. We will need to work with them on the best uses of soil surveys in many places.

Developing nations are experiencing similar problems with urbanization, agriculture, and the environment. Many of them not only recognize the value of soil surveys, but also have soil survey programs based on scientific principles developed by the National Cooperative Soil Survey. Many of their key staff people have bee" trained at American universities. Through the State Department's Agency for International Development, SCS and experiment station staffs and others have helped many countries improve their programs. We are likely to do eve" more of this "consulting" work in the future.

Undeniably, the demand for soil surveys is greater than ever, and it will continue to grow, We need consistent basic soils data on rural land and on land near urban centers...on prime farmland end on not-so-good farmland...on public and on private land. We must be ready with reliable soils information to meet the future demands we can foresee and those we cannot predict.

At the same time, the National Cooperative Soil Survey--just as every other program--must face the challenge of inflation, perhaps the most important problem in this country. President Carter has proposed voluntary price and pay standards for private companies. He is setting an example within the Federal government, by:

--enforcing strict spending limits and a moratorium on new income tax cuts;

--limiting Federal pay increases and limiting job replacements;

--curbing costly new regulations; and

--promoting more competition in the private sector.

The Soil Conservation Service 1980 budget request for soil survey has been cut by $5 million, and we will not be able to carry over funds from 1979. We will have to find ways to maintain the quality and momentum of the soil survey in spite of the cut in SCS funds, and we are looking to State and local governments to bear a larger part of the cost. We do recognize that they are feeling the inflation pinch, too.

All of us will need to take individual responsibility in the fight against inflation--to do a better job of managing the funds and the time we do have. We must set priorities and stick to them to get the most for each soil survey dollar.

We must also look at everday activities for ways to save money. For example, we have made remarkable gains in publishing soil surveys--from fewer than 50 a year to more than 100. At the same time we have trimmed the costs for printing and binding from almost $28,000 per survey (in today's dollars) to $16,000. Computers, word processors, and better scheduling have been mainly responsible. I would add that these savings have not been made at the expense of quality. The soil surveys have actually improved. Any idea that increases efficiency and productivity can help us make do with a tighter budget.

The soil survey program must adjust to one more set of changes in the 1980's--and that is to shift some people and funds among States to accelerate soil surveys in critical areas, to finish the mapping job, and then to phase down active mapping and to phase up the assessment and interpretation of the many kinds of soils we have delineated.

I'm convinced that professional soil scientists in all of the agencies and institutions represented here can meet all of these changes. I'm convinced you will find the 1980's an interesting--even exciting--time to work.

We will need to help each other improve our professional ability.

We will need to freely exchange ideas among soil scientists, soil conservationists, agronomists, geologists, biologists, and colleagues in other sciences.

We will need to communicate not only to other scientists but also to the users of our information and the taxpayers who foot the bill. As you discover new uses and new interpretations for soils data, you also will need to look for new and clearer ways of describing those interpretations and the value of their use.

We must be sure to maintain the highest standards of professional ethics and responsibility. In writing a manuscript for a soil survey, for example, professionalism means that you do not let it leave your hands until you are certain of every fact, every statement. You can't rely on someone up the line or in "that other agency" to catch your error.

Every cooperating Federal, State, or local agency...every experiment station...every College... every soil scientist plays an integral part in the National Cooperative Soil Survey.

We depend on each other to help the soil survey continue to guide present and future generations in protecting and using natural resources.

Soil Survey in Canada

John H. Day
Canada Department of Agriculture
Ottawa, Ontario

I wish first to thank you for the invitation to participate in this work planning conference. My colleague, Dr. Wayne Pettapiece, and I are very pleased to be here. Dr. Pettapiece is Senior Pedologist and correlator for the Alberta Soil Survey. We also bring greetings from our director Dr. J.S. Clark and our other colleagues many of whom are known to you.

Since your last meeting in 1977, at which Dr. John Shields reported, most soil surveyors and many soil scientists in Canada devoted much of their time to the final preparations for the International Soil Science Congress in Edmonton. From this point in time I believe most of us are happy to have done it and happy to go on to other things at a somewhat slower pace.

Soil Survey

Soil inventories continue in all provinces. In some, we are just now completing the first small scale surveys that will indicate the localities where larger scale surveys are warranted. The northern parts of Ontario, Quebec, Manitoba and Saskatchewan remain for the most part unsurveyed as are large portions of the Yukon and Northwest Territories.

The southern areas where agriculture and urban concentrations are located are completely covered by medium intensity surveys. We are conducting detailed surveys in urbanizing areas. Unfortunately we still have a backlog of unpublished reports and maps that difficult to banish. We instituted procedures to more quickly release provisional naps and legends to knowledgeable users during the course of the survey and upon completion of the field work.

As Dr. Marlin Cline wrote in the bicentennial paper of the Soil Science Society of America (Vol. 41, p. 253) "We have been compelled to acknowledge that soil taxa and mapping units identified by the same name are two distinctly different things". To define our terms and mapping practices we will in the next year publish a "Soil Mapping System" for trial and evaluation.

Soil Information system

Soil map data is stored in the cartographic data subsystem. The subsystem is developed to the point that we can remove the digitizing and other errors in about four passes and thereafter "plot" a clean map. Single-factor maps or interpretive maps are then plotted.

The soil data subsystem handles all non-cartographic data files such as soil profile descriptions, soil analysis, soil names and performance-management. The latter file is the least extensively developed, the soil descriptions and soil analytical data files the best developed.

Land Evaluation

The land evaluation programs, initiated in 1976. was designed to develop procedures concerned with assessing possibilities in the use of land, with the effects of these on the benefits obtained from land, and with the means through which desirable alternatives could be understood and undesirable avoided. The objectives of the program include:

a) to develop and maintain a comprehensive data base of land-related knowledge on rural land use and food production, to be used in advising primary producers, policy makers and governments.

b) to develop methods to evaluate rural land use on the basis of climate, soil and economic criteria, and to use these to assist and advise in planning rural land use.

c) to develop methods to evaluate the effects of government policy and policy tools on rural land use change.

d) to develop studies to test the developed methodologies in critical areas and to refine them where necessary.

The program has evolved and developed primarily by means of research projects carried out under contract. Its achievements to date are the development and planning of a manageable proposal for a first phase land evaluation program, and the subsequent application of the recommendations of this proposal to bring about the development of prototype methodologies and the collection of suitable data bases to deal with the problems of land evaluation. We are now entering a phase of refining and testing of the methodologies and the preparation of example studies and test evaluations comparing alternative methodologies and alternative sources of data.

Projects in progress include the following:

1. Growth stage maps for corn and cereals.

The objective is to prepare crop suitability and phenology maps for Quebec. Yield data, crop development data, soil data and climate data are being collected.

2. Climate statistics for the Canadian Great Plains

The objective is to prepare normal climatic data synthesized on a 10 km grid from Atmospheric Environment Service Station data.

3. Relationships between crop water balance and crop yield

The objective is to develop and evaluate phenological crop models with emphasis on yield prediction for pasture and hay crops in the Peace River region. These models will be based on quantitative relationships between crop yield and climate, soil water supply, related soil properties and crop characteristics.

The study aims at developing yield assessments on a regional basis, in keeping with the requirements of the national land evaluation program. It will address the problems of inherent soil variability within and between mapped soil units as the variability affects regional yield prediction, minimum soil and climatic data requirements for acceptable accuracy in yield prediction, the nature and extent of modifications required to adapt models developed elsewhere to conditions prevailing in the Peace River district of Alberta.

4. Land evaluation in Saskatchewan and Ontario

The objectives in these studies is to develop methodologies for crop grow and yield **modelling** for wheat, barley, corn and alfalfa hay.

NATIONAL TECHNICAL WORK PLANNING CONFERENCE
OF THE NATIONAL COOPERATIVE SOIL SURVEY
San Antonio, Texas
January 29 - February 2, 1979

SOIL SURVEY IN LAND RESOURCES DEVELOPMENT CENTRE

by

Dr. J.R.D. Wall
Project Manager
Watershed Management Project
El Salvador, Central America

Firstly, I would like to thank you on behalf of my Director, Tony Smythe, for the invitation asking him to attend this working group. I have been nominated to attend in his place and very much appreciate the opportunity of meeting fellow workers and being present during their deliberations.

Secondly, I regret that I have been unable to bring with me details of LRDC projects currently in operation so will simply give an outline of LRDC work and follow this up with a description of the project that I am personally familiar with, that in El Salvador.

I think it is worthwhile making it clear that soil survey in UK is undertaken by two different types of organisation. On the one hand there are national surveys, resembling the NCSS of USA, in England and Wales, Scotland and Ireland, and on the other hand there is soil survey work being carried out by Land Resources Development Centre in the Ministry of Overseas Development. This latter is specifically at the request of governments of developing countries; it generally takes the form of bilateral aid projects designed specifically to answer requests for advice on development strategies in large areas. There has been a trend in the last year or two to move beyond the giving of recommendations to participation in implementation. At the present there are some 8 projects in hand in 7 countries utilising 50 environmental and other specialists.

Almost all projects require the fielding of a multidisciplinary team of which the pedologist is generally a basic member. The soil input may be in the form of special studies, such assingle-attribute maps, or general-purpose base surveys at third to fifth order. A few order 2 surveys have been done, such as for research stations. Interpretative maps are commonly required based on the soil map.

We have found for many surveys, covering large or small areas, that the land system concept is a considerable help, firstly in understanding the landscape and breaking it down into ever more uniform areas, and secondly in forming the basis of both soil association maps and land management units. The areas where the implicit relationships between soil, lithology, landform and vegetation seem most obscure are in geologically old, pereplsined landscapes such as in continental Africa; the relationships are clearest in geologically youthful, topographically varied landscapes such as the Pacific Islands, Mexico, Malaysia.

The Pedologist, like all team members, has to be versatile as the work may move him from desert to humid tropics to subalpine environments on consecutive projects.

Currently LRDC soil scientista in multidiscipline teams are working in CYprus where an ambitious project is being evaluated to convey water from the better endowed south west part of the island to the drier south east for domestic consumption and irrigation purposes; in southern Sudan to assist in vital reafferestation of the Imatong Mountains for internal wood needs; in the Cameroon8 to map the best areas for expansion of rubber, oilpalm and coconut; in Sumatra for defining areas suitable for extensive resettlement of peoples from overcrowded Java, in two regions of Tanzania for national assessments of land use potential and planning, and in El Salvador for river catchment management planning and implementation. It is this last project that I shall now describe, as an example of the current trend in LRDC to add to the study phase implementation.

El Salvador Sits squarely on the circum-Pacific volcanic belt and consists essentially of Pliocene and younger basaltic/andesitic volcano Systems. It is Subtropical with a marked wet Seas"" - dry Season Sequence strongly affecting agricultural activities. At 210,000 Km^2, it is the Smallest american country, yet with a population in 1978 estimated St close to 5 million is one of the most densely peopled. The Study area, only 70,000 Km^2, comprises the catchment of the Acelhuate River and includes the metropolitan area of the capital city San Salvador. The population of this catchment is close to one million and is the most densely populated catchment of all of Central and South America.

This fact lies St the root of the problems which the LRDC team is studying, and which may be summarized as follows:

1. There is considerable pressure on the land for subsistence agriculture crops, chiefly maize and beans. These are traditionally grown by methods which take no cognizance Of the need to conserve soil. Clean cultivation on the widespread steep slopes, which reach 35" and more, is characteristic. The consequences of this under the typically heavy rain Storms are physical Soil loss, reduced soil fertility and greatly increased sedimentation in the river net. One major dam used for hydro-electric power for example, has its estimated life reduced by one half as a result of this sedimentation.

2. The ever-increasing, barely restrained urban spread has caused disruption and disorganisation of natural drainage, concentrating discharge into Some valleys St the expense of others. This has drastically increased river erosion to the point where airport runways, urban housing developments, new roads, Sewage outfalls, for example, are being actively threatened. Affecting this issue considerably is the presence of young, very weakly consolidated erodible, pumicitic ash deposits beneath the city reaching depths of 100 m or more, but thinning out northwards where basaltic clays are dominant. These two extremes of pedologic materials are expected t" handle and react very differently both to natural erosion and to erosion control measures.

3. The rapidly increasing urban land, squatter colonies along barancas, zones of industry and manufacturing (El Salvador is the most intensively industrialized central american country), the lack of a unified sewage treatment system, the ineffectiveness Of laws controlling pollution the 6-month dry season, all lead to water supply and pollution problems which threaten public health, future urban growth, and irrigation and fishing development downstream.

   To firstly examine problems and to produce a catchment management plan, which would be a model for other catchments in the country, the government of the United Kingdom is fielding a team containing the following Specialists: pedologist/geomorphologist, agronomist/agricultural engineer, planner/extensionist, economist, hydrologist, biochemical engineer, sociologist and land tenure specialist. The work is divided into a study phase of about one year and, depending on the approval and financing of the plan, a phase of implementation of up t" four years.

The place of the Soil Survey in this Scheme is to provide base information for the other specialist.

1. The agronomist/agricultural engineer requires the distribution of main soil types to facilitate correlation between soil and crops, present and potential, and to enable appropriate conservation treatments to be designed.

2. The hydrologist needs to know the soils most susceptible to river erosion.

3. The whole team needs to know the soil pattern in order to produce land capability maps and to design optimal ways of allowing orderly and planned rural and urban development.

Ideally a" order two or simi-detailed soil survey would be desirable. However, there are time and staff restraints which dictate that the best way to achieve the required information is by maximum use of airphoto interpretation to delineate physiographic units and to examine the majority of these by use of sample strips, namely the lend system method.

Fieldwork for this is nearing completion as sampling of characteristic soils gets under way. It is anticipated that the soil map will be produced et 1:50000 using associations of sub-groups possibly phased by depth and texture.

The preferred taxonomic system in El Salvador is the USDA Soil Taxonomy. This should work well in general but, based on previous experience, I anticipate a few problems. As illustrations, there are extensive areas with mollic epipedons overlying volcanic ash: erosion in such areas leads to juxtaposition of soils of two orders depending solely on the depth of this epipedon. This seems undesirable.

The volcanic ash in weathering will be difficult to allocate to Inceptisols or Entisols in some instances without detailed laboratory analyses which may not be possible. Furthermore, the presence of allophane-rich soil is know" to produce difficulties in mechanical analysis due to pseudo aggregation on drying: this results in false clay values and wrong assessments of exchange activity and base retention.

Identification of the argillic horizon may also prove difficult in the clay-rich basaltic soils, even with resort to thin sections and mineralogical analysis.

However, these are all "ifs" and "buts" and hopefully taxonomic classification will not be so troublesome. I console myself with the fact that in the end it is not the name that counts but the actual descriptions.

On the whole I like the USDA Soil Taxonomy and realize that it is still subject to modifications and improvement. I acknowledge the enormous amount of work that has gone behind it but would urge greater speed in response to overseas studies and suggested improvements in order that acknowledged deficiencies can be overcome: I am thinking specifically of Guy Smith's proposals for a new order of Andisols, and other suggestions for improving Oxisols.

I would like to round off this talk by making a few remarks on some of the committee meetings I attended. With respect to the utility of the Soil Family class, this is something which I shall have to consider carefully on my current project. It would seem however, that as a mapping unit it's advantages are few and that savings in time might be offset by the need to establish and characterise sufficiently well the component series.

With respect to mapping unit variability, I can mention two ways in which the team has attempted to assess or quantify this in previous surveys. I" one, in the Solomon Islands, where the land system approach was successfully used, the fieldwork concentrated on developing soil-land facet links (the landscape component which makes up a land system and which is fairly uniform in ecological characteristics). Using a transparent dot grid overlay randomly set on stereopairs the number of dots on different facets were counted and, using the already established facet/soil relationship, some semi-quantitative idea of the soils per mapping unit (land system) could be obtained.

The other method was used in Nigeria where a comparison was tried between the methodology of a more-or-less conventional land system analysis and free-traverse soil survey and one in which the soil pattern of land system's is enalysed by pre-designed, statistically selected traverses. This method has been evolved by David Lang of LRDC and I believe is currently in use in a project in Tanzania. I do not have figures showing the relative savings in time or of the relative accuracy of this method but suspect that the improvements are significant.

Finally, I sat in on one committee session in which the future staffing of the USCS was being considered and when some worries were being implicitly expressed regarding the long-term needs for soil specialists. This made me smile in view of the great amount of soil work still remaining overseas - and so I suggest that in the light of this, because of the undoubted salesmanship expertise of Americans and in view of your eminently salesworthy product, Soil Taxonomy, you begin sending more pedologists overseas. I have a feeling that if you don't you will find that you will lose control over the development of your model.

NATIONAL TECHNICAL WORK PLANNING CONFERENCE
OF THE NATIONAL COOPERATIVE SOIL SURVEY
San Antonio, Texas
January 29 - February 2, 1979

SOME PROBLEMS IN SOIL CLASSIFICATION AND SOIL SURVEY BROUGHT UP DURING RECENT FIELD WORK IN LATIN AMERICA

by

Dr. P. Segalen
BONDY, France

During the last few years, ORSTOM pedologists have been working on soil surveys in various Latin American countries. The most important ones have been carried out in Ecuador and Venezuela.

In Ecuador, the whole country is being mapped at various scales depending on the possibility of penetration, the availability of maps and local requirements; soil maps are going to be published at scales from 1/100.000 to l/500.000.

In Venezuela only the southern part of the country, known as "Territorio Federal de Amazonas", is under survey. This is a most difficult country to get into with hardly any roads but only some large rivers and a few landing strips. Forest covers most of the land, the rest is under savanna; more than 2000 meter high mountains take turns with low lying swampy plains. The rainfall is 2 meters and more.

In these countries two sorts of problems have arisen. The first concerns the soil classification, and the second the soil survey itself.

The soil legend is generally established on a physiographic basis. Various areas related mostly with relief are delimiteted and the soils found therein are named at the subgroup level using the Soil Taxonomy. Provisions concerning the possible use of the soils are made.

Some difficulties were encountered when the question arose to give names to some high andean soils. Most of the ridges are covered by recent volcanic ash, mostly endesitic or dacitic material, which weathers to allophane; the younger soils are endepts of various types. Older ones no longer contain amorphous material but lattice clay minerals. They show conspicuous mollic epipedons and the soils did not seem to fit with the definitions of the Soil Taxonomy. The man in charge of the survey, F. COLMET-DAAGE, was lucky enough to make field trips with Dr. Cuy SMITH, who made new proposals for andepts and mollisols to take into account the properties of these particular andean soils which can be found also in nearby Columbia. In Southern Venezuela, soils showing the morphology of solonetz were found. But pH is about 5 and exchangeable sodium is 0,1 mé/100 g. In the Soil Taxonomy these soils are accounted for as tropaquults.

In Southern Venezuela no maps are readily available for most of the area under study. Air photographs are often covered by clouds and only radar photographs can give a clear view of the land.

In this area, Landsat imagery has proved very useful. A comparison has been made between a classic soil survey and the information carried by different coloured views. The following methodology has been proposed and tried by G.SIEFFERMANN who worked several years in this area.

First of all a check area has been chosen on a diazo print enlarged at the scale of l/100.000. This area carries five or six different soil units identified at subgroup level. The total surface is about a hundred square kilometers, is easily accessible, and represents also the vegetation pattern of the surrounding area.

The check zone is spotted on the diazo sheet and a grid map gives its coordinates. These limits are given to a computer through a punch card.

Each radiometric channel has been studied separately end those that give the beet information are retained: channels 5 and 7. The histograms given by each channel are cut out into 8 or unite. The computer outputs are compared with the ground truth with a tracing et the same scale of about 1125.000.

Different combinationa of chennele can be made end the comparison of the output of different combinations made with the ground truth allows the selection of the beet ones.

For instance, channels 5 end 7 allow to single out:

- rivers and sometimes to distinguish between black water end white water rivers.
- wet forests
- dry forests
- tree savannas
- open savannas
- swamps,

end so on.

This type of analysis leads essentially to the delimitation of physiographic units. But as most of them are closely related with Taxonomic unite, they can be wry helpful to define soil boundaries.

Moreover, the diazo prints at the • eel. of 1/1.000.000 can be used to prepare high quality topographic documents.

The conclusion of this study allows to recommend the following steps during a small scale soil survey.

1. Choose on the diazo print 4 to 6 of about . hundred square kilometers areas of easy access, that seem to be quite representative of the total zone under study.
2. work out with the help of thr computer through various combinations • first drrft.
3. Then check in the field the validity ot thr limits and take notice ot the necessary amendments.
4. Work out with the help of thr computer • new document of the whole area under study, taking into account thr amendments.
5. A new field check is necessary before the final draft.

So, the roil survey of these two countries base raised quite different problems. The first concerned the Soil Taxonomy itself that could fortunately be solved with thr help of Dr. GUY SMITH. The second concerned a methodology for thr survey itself. A proposition was made using landsat imagery.

Last year, • helicopter was tried. It is prrtty costly but enables to land in my open area. Heavily forested zones are still accessible with dittioulty.

Each image 180 x 180 km

This week you are assembled as the "national technical work planning conference of the national cooperative soil survey." One word in that title, reveals that there is in fact public participation in the soil survey program. That one word is cooperative. It means people working together for a common purpose.

This week the people working together include those with an interest in forestry, land management, farming, research, teaching, resource planning and, of course, soils. This working together does not take place in a supervisor/subordinate relationship, rather as colleagues striving toward a common goal.

At this planning conference, in an atmosphere of free give and take, people are putting forward ideas, discussing issues and trying to influence others. We could label this being cooperative. We could also call it public participation, if it meets the definition we often use. Let's try this definition: public participation is activity undertaken by the public to influence the behavior of those empowered to make decisions. If anyone here this week has undertaken an activity to influence the behavior of those empowered to make decisions about the soil survey program, then we have been having public participation. You decide for yourself. My own feeling is that in the soil survey program there is a commitment to public participation, as this conference demonstrates.

I am aware of some interesting public participation activities in soil survey in Illinois, New York. and Louisiana. I'm sure you know others. You in soil survey are in step with the current philosophy that encourages government to provide opportunities to the public to participate.

This philosophy is spelled out in Executive Order 12044, which says that when developing new programs (or regulations) or making major revisions to old programs there must be an early opportunity for the public to participate and comment. The philosophy is furthered by the Secretary of Agriculture in Memorandum 1955, which extends the President's directive to all U.S. Department of Agriculture (USDA) decisionmaking that has broad scope. This memorandum establishes a decision calendar and requires public participation related to these decisions. Along with this Memorandum,

---

Notes prepared for presentation by Ida O. Cuthbertson, Community Planner, Soil Conservation Service, at the National Technical Work Planning Conference of the National Cooperative Soil Survey, San Antonio, Texas, February 1, 1979.

USDA gives the following guidelines to it's agencies, including Soil Conservation Service (SCS), for making these decisions of broad scope (such as substantial change in total program outlays):

. SCS is directed to actively solicit public comment,
. SCS is encouraged to use several means to obtain the greatest possible public input,
. SCS is required to have a related Public Participation plan as we begin this decisonmaking. and
SCS is required to have a Public Participation Office reporting 'directly to the Administrator.

And SCS is meeting these requirements at the national level.

You may be interested in the definition of the term, the "public", according to the Executive Order. The public includes other Federal agencies, State and local governments. businesses. organizations, and individual members of the public. The SCS definition says the public includes all those who have an interest in or who may be affected by an SCS-assisted activity. The two definitions are compatible.

I mention these directives to show the emphasis that the Federal Government places on public participation. Public participation is part of the way that government does business these days.

Given this emphasis, three major questions come to mind:

First. how much public participation are we to have? What arc we required to do?

Second. how much ought we to have? After we do what is required, should we do more?

Third, how much do we inform the public? How much do we tell people so that they can participate in a meaningful way?

I will attempt to answer these questions. and I say "attempt" advisedly, because for each of these questions there is no single, hard and fast answer. There may be a range of answers, depending on the situation. But is there another question lurking in your mind that we should address first? Are you asking yourself the question - Why bother with public participation? "Why bother" is a legitimate question. And there are several answers:

With public participation we have every reason to expect that a better decision will result, partly because the decision will have a broader base of support. When representatives of interested groups or individuals participate, they are buying into the decision. They have a stake in the outcome. Public participation often leads to decisions that are feasible, likely to be implemented. Through public participation activities, the decision maker may get early warning about potential trouble. That is valuable information. In soil survey. the decision maker could get knowledge about the needs of potential survey users. That, too, would be useful information.

In fact public participation can be one of the sources of information that is needed in decisionmaking. Which is why, in the Federal Government, public participation is the way of doing business these days--to improve decisionmaking.

Second, in answer to the "why bother" question, we know there is much skepticism about government these days. Proposition 13 is a watchword. More citizens want to know more about how the government spends their money. We invite people to participate. Hopefully, this will build trust.

The bottom line answer to the "why bother" question is that the government belongs to the people. We in government are elected or appointed officials, entrusted with some very important business that we conduct for the public. When people say--as they have over the past 15 years--that they want more opportunity to help make decisions, then the people are to be given the opportunity. We retain the responsibility for making technical decisions because the people authorized us to do this. We are their trustees in this regard: And we have the responsibility for making operational decisions. But in the matter of program planning, priority setting. choices among alternatives--the people rightfully may give us their views and we will consider them. So these are some benefits from public participation activities and some reasons why we offer these opportunities.

Now, back to the three big questions. As I offer some answers to these questions, you might want to have in mind an actual case--say, updating the State long-range plan for soil survey. You might also want to keep in mind this overall guide: Be practical. Use common sense.

Let's take that first question: If we are going to provide opportunities for the public to participate, how much opportunity should we provide?

Answer: Enough opportunities so that the people or their representatives who have an interest in the issue or will be affected by the decision will have an opportunity to express their views, in the interest of better decisionmaking. Let's look at a relevant situation: Updating a long-range plan. As I understand it, in each State there is to be a long-range plan for completing the soil survey. Each year representatives of the cooperating agencies meet together to update the plan. What the representatives do is discuss the plan and make necessary adjustments: Affirming some decisions and revising others. You could call this "partial replanning:"

I suspect these decisionmakers use some kind of planning methodology, perhaps something like this, perhaps not in this order:

Recognize the long-range goals,
Consider the objectives for the coming year or two,
Discuss the product that the survey will yield,
Identify the resources available: Personnel, time, dollars,
Look at alternative ways of using the resources to reach the objectives,

Discuss potential users in fields such as health, environmental quality, agriculture, land management, real estate, forestry, building, banking, appraisal, planning,
Adjust the implementation schedule, if necessary.

After the agency representatives discuss these points, they may ask theeselves: If we are going to provide opportunities for the public to participate, how much opportunity should we provide?

Here are three guidelines, announced by USDA, that help to answer the "how much" question:

Participation will be meaningful.
It will be broad.
It will be open.

To be meaningful, the public is to have an opportunity to express its views before the decision is made and the public is to be asked to comment on the major issues. To have meaningful participation in updating the long-range plan, the representatives ask themselves two questions: (1) What do we want to ask the public to comment on? (2) When, during the process. do we want to hear comments from the public? After these questions are answered, the agency representatives decide how to do this. There are several ways. For example:

- Go to the people and ask them some questfons, or
- Ask them to come to you, then ask them some questions, or
- Send a letter with a card to mail back the answer, or
- Phone them.

In the case of updating the long range plan, a workshop might be a practical method to use. But whatever way is chosen, the people must understand what they are being asked. why their views are wanted, and what will be done with their answers. This is necessary to meet the requirements that participation be open and meaningful.

In the case of updating the long-range plan, it might work something like this: The representatives of the soil survey cooperating agencies would meet to discuss the long-range plan, decide what questions they want to ask participants, and plan to hold a workshop at a later date. Then the workshop would be planned so participants would accomplish some meaningful task. After the workshop, these representatives would meet to consider the comments, then make decisions, including adjustments to the long-range plan. It is likely that some suggestions made by participants could not be accommodated until the following year, and some suggestions not accommodated at all.

The next step in planning the workshop is to assign people to carry Out these tasks and set some tentative deadline dates. In making assignments, be sure to include the information activities that are necessary to inform the public about updating the long-range plan. Now the representatives have planned for participation. This is the same kind of participation planning that is being done at the national level relative to national decisionmaking for the soil survey program.

Going through that planning process provides most of the answers to our first question: "How much must we have? What are we required to do?" In a phrase, the answer is enough to help make sound decisions.

The next question is "ttow much ought we to have?" or "How much do we do in addition to the amount we must have?" I would suggest that the answer to Question 2 is the same as the answer to Question 1: ... enough to help make sound decisions. In other words, we don't have a minimum standard and then optional increments, each of which presumably produces incrementally better program planning and implementation. You plan to provide participation opportunities that you think will help make sound decisions. If you need to adjust your participation plan later, you can.

Wc have been talking about agency representatives planning to provide opportunities for the public to participate--when people can undertake activities to influence the behavior of those empowered to make decisions. But what about the public? How do people feel about activity that we call public participation? Put yourself in their shoes for a moment. If you are invited to participate in some decisionmaking, your first reaction may be: "I'm thankful that as a citizen I am not required to participate, that I have the freedom to do so or not to do so--just as I have the right to vote or not vote." You may feel that you need more information before you will decide to participate.

Still standing in their shoes, recall that, as an interested citizen, you would want to know about the opportunity to participate and about the issues that are being decided. In our example, people would want to know what the long-range plan is; how a soil survey is made. Then, before the interested citizen would decide to participate, you must feel that the propdsal will somehow affect you. Thirdly, as this citizen, you must feel that by participating you can affect the decision to be made. Fourth, that by affecting the decision, this will somehow result in a better outcome for you. Finally, as this interested citizen, you must feel that you have the finances, time, intellectual and psychological resources that it takes for participation. so after progressing mentally through these steps, you, as the interested citizen, are likely to participate, unless at the last minute something else happens that blocks the path. On the other hand, if you are another citizen, invited to participate, you may feel an obligation to get involved, if you can spare the resources.

What do we learn from this exercise of walking in the citizen's shoes? We learn that:

1. The information campaign related to public participation is very important. It is essential if the citizen is to know about the decision to be made.

What else could we learn by walking in the citizen's shoes?

2. If the citizen is asked to participate and expresses some opinions, the citizen expects these opinions to be taken into consideration in making the decision.
3. If the citizen is asked to participate, then he or she must choose to spend time, money, and brains on participating, rather than on something else--such as Monday nite football.

4. If the citizen is asked too many times to participate, or is given a task too complex, or no task at all, the citizen may get "worn out" or discouraged and become unresponsive.

Looking at public participation through the eyes of the citizen may help decisionmakers plan for it. The important guides to keep in mind are:

Be Open--give the public the information they need.
Be Broad--invite groups from a wide range of interests.
Be Meaningful--make this a useful, pertinent activity for both citizenry and government,

Here then are some rules of thumb you might use;

- Tell the people about the proposal or decision to be made, the pertinent issues we identified. and the decisionmaking process. Use plain language--forget the agency jargon and technical language.
- Invite people to participate, explain how they can respond, and when want to hear from them.
- Tell them how their views will be considered in making the decision.
- Ask them to comment on specific topics, such as:

  -- A goal for a Z-year program.
  -- Several alternatives.
  -- The entire proposal.
  -- Priorities among a number of things.
  -- Related problems that they foresee.

- And ask them to give you their reasons for saying what they did say.

These rules of thumb go a long way toward answering Question #3, "How much do we inform the public?" The short answer is: Give people enough background about the decision, issues, and process so they can thoughtfully provide meaningful comments.

How you tell them is as important as what you tell them. Here, the Information Officer can help immensely. Put out a brochure or flyer. You can use simple diagrams to explain the decisionmaking process and pictures to show how you make a soil survey.

And, as you follow the guidelines, are practical, and use common sense, feel assured that if you make a good faith effort to provide opportunities for open, broad, and meaningful participation, you will be on the right road. Public participation can be a fascinating adventure. Good luck to you as you begin.

Thank you.

NATIONAL TECHNICAL WORK PLANNING CONFERENCE
OF THE NATIONAL COOPERATIVE SOIL SURVEY
San Antonio, Texas
January 29 - February 2, 1979

COMPLETING SOIL SURVEYS NATIONWIDE

by

Victor C. Link
Director
Soil Survey Operations Division

It is the goal of the National Cooperative Soil Survey to complete soil surveys nationwide on all lands at the earliest practical date.

Approximately 67% (1.43 of 2.27 billion acres) of the Nation has soil mapping completed. This leaves approximately 840 million acres to be mapped. Current annual mapping production is about 55 million acres. At this rate it would take about 16 years to complete the remaining acreage. Delaware, Maryland, Rhode Island, Hawaii, and the Caribbean Area are already completed. Other States range from about 35% to nearly 100% completed. At the current rate of production, some States will require 25 to 30 years to complete the onceover soil mapping. Without management the stated goal will not be reached.

To achieve a" orderly completion, some adjustments of positions and CO-02 funds between States will be necessary. A long range plan will be developed to guide adjustments. It is anticipated that States with firm commitments with local cooperators for acceleration and completion of statewide mapping can be allowed to complete their plan as scheduled.

The plan will be based on the current funding level and available soil scientists, both SCS and non-SCS. Adjustments will be made to the plan as conditions change. There will be provisions in the plan for maintaining soil scientists in States after mapping is completed. The soil scientist staff remaining will be determined by program needs and workload analysis.

NATIONAL TECHNICAL WORK PLANNING CONFERENCE
OF THE NATIONAL COOPERATIVE SOIL SURVEY
San Antonio, Texas
January 29 - February 2, 1979

SOIL POTENTIAL

by

Donald E. McCormack
Washington, D.C.

:

Soil potentials are ratings of soil quolity with the application of modern technology to overcome soil limitations. Their purpose is to help achieve sound decisions about the use end management of land. 'They are considerably more versatile and more useful than ratings of soil limitations, and avoid some of the problems that users have with soil limitations, e.g., if a soil has severe limitations for a given land use, then it shouldn't be used for that put-pow. This is not true of course, and was never intended, but is a misinterpretation that is much too common.

We appreciate comments by Wil Westerveld indicating use of soil potentials in the Netherlands. We hope that the concept can be tested in other nations and by our cooperating agencies in the U.S. We would like for you to keep us informed of your use of soil potentials and send us copies of the assumptions, definitions, criteria, and rating classes that you develop.

The rating of soil potential is achieved using the following expression:

SPI = P - CM - CL, where

SPI - soil potential index

P - performance standard

CM - corrective measures

CL - continuing limitation

Each term is defined in the National Soils Handbook, Section 404, and we won't go into that detail here. We would like to see more efforts like the Canfield (Ohio) Subdivision Regulations where corrective measures were discussed intensively locally, and adopted in ordinances. To hove one set of specifications for design of homes and streets that applies to all areas (all soils) of a municipality (or county) is ridiculous, and especially where detailed soil surveys ore available.

Developing ratings of soil potential requires that soils bc placed into on array based on SPI, and that class limits bc set locally. They arc intended to cover only the local universe of soils. Local data on measures and their costs and on the severity of continuing limitations are used. To make thie work the way it should, the soil scientists must recognize that they have a big limitation. That limitation is the grand delusion that they are the ones who know about soils. That simply isn't true. The people who know by fur the most about soils are those who use them--former, tho engineer, the contractor, etc. Our job is to organize what they know so that it may be properly npplicd to new problems and new areas.

Pilot exercises have been conducted in Leon County, Florida and Medford, Oregon, the former for septic tanks and the latter for pear production. In Florida, two sanitarians of the county department of health and two from the State participated for three days and completed the basic system.

The purpose of these projects was to test the procedure outlined in NSH Section 404, and to provide training in this procedure. We believe that additional pilot exercises should be conduct-cd to assure that State staffs are properly trained in the procedures, we suggest that the TSC assist with one project in each State.

Whether or not to publish soil potentials in soil surveys has been left up to the States. If the State feels that publication would help achieve full use of the soil survey, then we will publish them. There are no plans to require coordination of the ratings at any level above the survey area. To do so would negate one of the major merits of the system.

NATIONAL TECHNICAL WORK PLANNING CONFERENCE OF THE NATIONAL COOPERATIVE SOIL SURVEY
January 29 - February 2, 1979

NORTHEAST REGIONAL WORK PLANNING CONFERENCE REPORT

Edward J. Ciolkosz

The Pennsylvania State University

The 1978 Northeast Cooperative Soil Survey Work Planning Conference was a meeting of Firsts. The First of these was that for the first time we operated under a written set of by-laws which spelled out the purpose, the policies and the procedures of the Northeast meetings. These by-laws were unanimously accepted at our 1976 conference. The second First was that we held our meeting in the sunmer (July 17-22, 1978) on the campus of the University of Connecticut at Storrs. All previous meetings were held in January in New York City. The summer meeting enabled us to have a half-day field trip in which we viewed soils and tobacco production in the Connecticut river valley. The summer meeting time was well received by the members of the conference and it will be continued for our next conference which is to be held June 23-27, 1980 on the campus of the Pennsylvania State University in State College, Pennsylvania. The third First was that the format of the conference followed that which was used in a few past national conferences. This was that all committee work was done by mail and a draft of all committee reports was distributed at the beginning of the conference. The reports were discussed in four discussion groups by the chairman of the committee. After this discussion the reports were revised and presented to the conference as a whole, and appropriate action was taken to accept the report and continue or discontinue the committee. This procedure was also well received by the conference and it will be followed at the 1980 conference. The last First was that the conference authorized a regional project. The committees on the project are to prepare and publish a soils map for the Northeast with an accompanying bulletin. The map and bulletin committees for this project are being set up and it is hoped that a draft of the map and bulletin will be ready for our 1980 Northeast conference. It is presently proposed that the map be at a scale of about 1:2,500,000 with associations of great groups as map units and the bulletin to be similar to the report "Soils of the Southern States and Puerto Rico" put out by the Southern region in 1973.

There were 12 committees in the Northeast Conference. In retrospect this was too large a number of committees and may be part of the reason only 3 of the 12 made significant contributions. I do not intend to summarize the results of all of these committees, but I just want to mention a few things about some of the committee work.

The Legal Aspects of the Use and Interpretations of Soil Survey Committee up-dated their 1974 report of environmental legislation in the Northeast and reported that some legislation has been passed that uses soil survey or soils data. The Use of Soils for Waste Management Committee developed a 54 page report with many guides and evaluations of previously proposed guides. Three topics, soil mapping unit composition, soil moisture and soil potentials, came up in more than one committee.

The need for a standard method and its immediate use to determine soil mapping unit composition was very apparent. A coordinated effort in obtaining soil water data particularly in relation to length of duration and soil morphology relations was also stressed. The Soil Potential Ratings for Selected Uses Committee generated a 30 page report and pointed out some problems where there is more than one possible corrective measure.

The following are some brief comments on the experiment station and special reports:

1. Septic tank longevity and the movement of nitrate and phosphate around septic tanks is being studied in Connecticut. These studies indicate that pollutants move in finger patterns in sandy soils overlain by finer textured material. Studies in Pennsylvania on soil morphological changes due to waste water irrigation indicate that also in finer textured soils there is a significant channeling of water through the soil.

2. Soil temperatures are being measured by many states in the Northeast both by the experiment stations and the SCS. This interest is related to the classification of soils into the mesic and frigid families as well as the possible relationships of spodosols to the frigid temperature regime.

3. Soil characterization work continues, at many of the experimental station labs, and a new characterization lab has been established at Cornell University.

4. Soil potentials are being studied in various experiment stations. In particular soil potentials on mined land is being investigated by Jerry Neilsen while on sabbatical leave at Penn State.

5. Everyone seems to he doing sludge application work. I hope someone is going to pull all this information together someday.

6. John Rourke reported on the Status and Future of the Soil Survey in the Northeast. John informed us that about 65% of the NE has been mapped, and that the Caribbean Area, Delaware, Maryland and Rhode Island are completed and that Connecticut, New Jersey and Pennsylvania are 90-95% complete.

7. Ron Yeck reported on the national soil survey lab. He reported that although the staff is smaller than the combined staffs of the pre-existing labs it provides more data by using a number of labor saving devices as well as more sophisticated data handling techniques. He also indicated that data from large projects are generated within 12 months and from small projects within 3 months.

8. Dick Arnold gave a very interesting presentation on quantifying the accuracy and precision of our soil mapping as well as its variability. If you are interested, the paper is given in the proceedings of the NE Conference.

NATIONAL TECHNICAL WORK PLANNING CONFERENCE
OF THE NATIONAL COOPERATIVE SOIL SURVEY
January 29 - February 2, 1919

Southern Soil Research Committee

Report of the Land Grant College Representative

of the

Southern Regional Technical Work-Planning Conference

of the

Cooperative Soil Survey

Fenton Gray, Chairperson

The biennial Southern Regional Work-Planning Conference of the Cooperative Soil Survey met at Jekyll Island, Georgia, on March 14-17, 1978 with H. F. Perkins and Morris E. Shaffer as chairpersons. Sixty-four soil scientists participated in this conference, representing 12 Land Grant Universities (Research, Teaching, Extension), Soil Conservation Service, Agricultural Research Service, Forest Service, Tennessee Valley Authority, NASA-ERL and the Department of Natural Resources and Environmental Protection. A list of names of those attending can be provided, if needed.

The invited speakers were:
Mrs. Lynn Cheek, the Executive Director for the Jekyll Island Promotional Association.

Dr. Henry W. Garren, Dean and Coordinator for the U. of Georgia Agricultural Experiment Stations reviewed the significance of agriculture to Georgia's economy. He emphasized the need for more agricultural research and extension now and in the future for the production of more food and energy.

Mr. Dwight M. Treadway, State Conservationist, for the Soil Conservation Service of Georgia pointed out that management and production is only half of the story. He made it clear that soil survey interpretations are essential in publications but needs to be displayed or made more useable by more people for making better land-use discussions.

Mr. Robert L. Wilkes, District Conservationist, Soil Conservation Service, Hinesville, Georgia talked about resource data for management of Coastal Zones such as soils, land-use and wildlife wetlands.

Mr. Warren Lynn, Research Soil Scientist, National Soil Survey Laboratory in Lincoln, Nebraska, outlined the cooperative research projects for soil survey in the southern states. A list was provided that divided the projects into active, completed and inactive.

Mr. Blake Parker, Soil Scientist on assignment to the Department of Interior, reported on the status of the national wet lands inventory of the eight states selected for a intensive study, three are of the southern states.

Mr. George Merrell, Engineer, Soil Conservation Service and the Remote Sensing Team of Reston, Virginia, gave a progress report on remote sensing and its relationship to soil survey. Remote sensing will be used more in the future and mini-courses are needed to more fully explain it to soil scientists.

Mr. Victor Link, Director for Soil Survey Operations Division, Wahington D.C. outlined the recent developments in the cooperative soil survey. He stated that more and better organization of data are needed in future soil surveys. Some updating and remapping will be needed in some states. About 63% of the U.S. is mapped.

Dr. H. H. Bailey, Professor of Soil, Science from the U. of Kentucky, compiled a report on the contributions the 12 southern states are making for Soil Surveys. His report states that the south is providing laboratory data and correlation support rather than actual mapping. Over seven FTE's are averaged for the 12 states which total 85 FTE's.

The chairperson of the following committees which were established previously presented reports developed through correspondence and at meetings prior to the conference to each of four small discussion groups:

Committees:

- I. Updating Soil Surveys
- II. Waste Disposal on Land
- III. Soil Potential Ratings
- IV. Kinds of Soil Maps
- V. Improving Soil Survey Field Procedures
- VI Soil Yield Potential
- VII. Remote Sensing

Finalized committee reports were presented to the conference. Some discussion evolved during the reports. Copies of these reports are available from Dr. Perkin of Georgia.

Much time was devoted to a discussion of ways to improve committee work in future conferences. The Steering Committee will pay close attention to the suggestions offered for improvement of Working Committees.

A field trip was made to Sapelo Island to study soils of marshlands.

Dr. Larry Wilding and Dr. David Pettry, Experiment Station Representative, were voted to the Soil Taxonomy Committee along with Morris Shaffer and Gray Aydelott of SCS and Forest Service, respectively.

The conference accepted the invitation from Dr. Paul Santelmann to meet in 1980 in Oklahoma. The chairpersons are Bobby Birdwell, SCS and Fenton Gray of O.S.U.

Tentative plans for the 1980 meetings are for near middle of March (13-17), at the Hilton Inn, Oklahoma City, which is near the airport with plenty of other facilities near-by.

Plans are for the Steering Committee of Birdwell, Gray Nichols, Pettry, and others to be named to meet in Ardmore on December 1 to make further plans for the 1980 Work Conference. This meeting is during the Region-4 ASA Soils Contest.

Plans for 1980 Meetings

The 1980 meeting, Southern Regional Technical Work-Planning Conference of the National Cooperative Soil Survey is scheduled for Oklahoma City during March 11-14 or March 17-21. These meetings are to be held in Hilton Inn which is near U.S. Hwy. 40 and near Oklahoma City Airport.

The steering committee consisting of Bobby Birdwell, Chairman and Fenton Gray, Vice-Chairman, Joe Nichols, C. M. Rutledge, D. E. Pettry, and B. L. Allen met in Ardmore, Oklahoma on November 1, 1978. After much discussion seven tentative committees were agreed upon for work during and before these 1980 meetings. The committees were:

1. Soil Characterization Use in Soil Surveys
2. Updating Soil Surveys
3. Taxation in Soil Surveys
4. Soil Variability of Mapping Units and Quality of Soil Surveys
5. Yield Potentials
6. Remote Sensing; NASA
7. Training (future and present)

NATIONAL TECHNICAL WORK PLANNING CONFERENCE
OF THE NATIONAL COOPERATIVE SOIL SURVEY
January 19 - February 2, 1979

Western Regional Soil Survey Work Planning Conference Report
by

L. A. Daugherty
New Mexico Stute University

The Western Regional Work Planning Conference met the week of February 13-17, 1978 in San Diego, California. More than 70 soil scientist wore in attendance representing the Soil Conservation Service, Forest Service. Bureau of Land Management, Bureau of Indian Affairs, Bureau of Reclamation, U.S. Geological Survey, Agricultural Research Service, Experiment Stations. rind the Soil Survey of Canada.

The initial session included talks on the following topics: "Organization soil surveys to meet today's needs"; "Hole of the Universities in the soil survey program"; "Role of Technical Service Cantor. SCS, In the soil survey program". Other discussions throughout the course of the conference included: a panel on research activities in the western states; a panel on remote sensing; a panel on design of soil surveys to meet objectives; agency reports; and a field trlp to look at a transect of the soils of San Diego County.

Most of the conference was on presentation end discussion of six committee reports. Most of the committee work was done prior to the conference. Each participant in the conference had the opportunlty to enter Into discussion on each report. The following suction dce3.e with the six committee reports.

Committee 1 considered soil eurvey operations. They explored ways to revise and modernize technical guides end suggaetcd that the TSC develop a form to display single mapping unit interpretations from the date bnnk. They evaluated the effectiveness of various training methods used with new soil scientists. The committee coneidcred end evaluated advantages Rained by mobility programs between states in contrast to mobility within a state in preparing a soil scientist for additional responsibilities.

Committee 2 delt wi th soil survey publications. They explored whet her wildlife interpretations should be made at a taxa level or be treated in the descriptive material of a general soils map. The committee recommended that soils-wildlife interpretations should be developed for broad landscape units. The National Committee gave a charge to this regional committee to develop a soil formation section for a selected MLRA. The regional committee does not consider a soil formation section by MLRA to be suitable for western states. The development of a no ll formation section by soil-landncupr relationships should be an option. Canned no.11 format Ion sections are not appropriate. The committee eva luat cd current map compilation procedures and suggested that map finishing should be done at the cartographic unit.

Committee 3 considored improvement of soil eurvey techniques. The committee recommended that persons with a good working knowledge of soil, vegetation and geomorphic relationships aid in the design of mapping units. especially for order 3, 4 and 5 soil surveys. Each field soil scientist should be given training in soil and lendscape relationships. Remote imagery (including aerial photographs) and its use should be given rquel status with eurvey staffing. The committee also recommended that the range of characteristics of a series description should be in a tabular format. The taxonomic justification should not bc in the range of characteristics unless needed to refine the series placement. During the field review process, more time should be spent on field checking the mapping units.

Committee 4 evaluated soil survey interpretations. A new interpretation form should be prepared and adapted for use by all agencies making soil surveys. A more detailed "How the survey was made" section should bc prepared with more discussion of sampling rates and statistical reliability of soil maps and interpretations. Interpretations for mass wasting should be based on observatio of past slope failure and related to named kinds of soils. The committee recommended that each state prepare soil potential ratings within the next two years.

Committee 5 was charged with assembling guideline8 for the interpretation of soils and soil material disturbed by mining operations. A table was compiled which gives guidelines for rating soil for use as cover-soil in strip mine reclamation. The committee recommended the definitions of Fluvents and Fluventic subgroups bc chongcd to exclude spoils by adding the phrase "in strata parallel to the surface" in the statements on organic carbon.

Committee 6 considered techniques for measuring source and yield of sediment. The USLE should bc used in the western region but with care, caution and good judgement. The establishment of additional erosion studies throughout the region Is encouraged with emphasis on benchmark soils.

The newly formed Western Regional Coodinating Committee on Soil Survey (WRCC-30) met in conjunction with the work planning conference. The general purpose of the committee is to allow Experiment Stations, through their representatives, to participate in the programs of the National Cooperative Soil Survey. This group is considering several projects includ ing the revision of the western regional soils map and development of a soil moisture map for the region.

The next conference is scheduled for the week of February 10-15, 1980 in San Diego. State Soil Scientists for the Bureau of Land Management and Area Soil Scientist of the Bureau of Indian Affairs with active soil survey programs will be now voting members. Future conferences will be restricted to 6 committees wi th a ceiling of 3 charges for each committee.

NATIONAL TECHNICAL WORK PLANNING CONFERENCE
of the
NATIONAL COOPERATIVE SOIL SURVEY

January 29-Febutary 2, 1979

Committee Number 1: Long-range objectives of the National Cooperative Soil Survey. (What should the standards and qualities be for the completed soil survey?)

Charges:

1. Cartographic quality and format of soils maps.
2. Standards of interpretations of taxonomic or cartographic units.
3. Standards of correlation of taxonomic units.
4. Soils survey staffing.

Introduction:

The preliminary work for the committee was done by correspondence. A set of questions was circulated with request for comments on those questions and on concepts not covered by the questions. The preliminary report was prepared by the committee chairman. Two sessions were held at the conference in San Antonio. The preliminary report was adjusted to incorporate the later suggestions.

Charge 1. Cartographic quality and format of soils maps.

Recommendations:

1. Spatial accuracy should be balanced to expected need. In some areas high altitude photographs provide an adequate base. In other areas orthophoto bases are necessary. High tine areas would benefit from a highly controlled coordinate system to assist in computer storage and merging with other map data. This requires nn orthophotographic base.

2. We recommend that soil survey maps in high use areas be stored in a computer system.

Other Important Comments:

il. Soil surveys should meet the accuracy standard of the National Cooperative Soil Survey. The detail should be matched to the expected use and management for the area. We expect that onsite investigations and more detailed maps for more intensive use will be needed for most, if not all, survey area*.

We must continue to strive for highly accurate delineation lines between units. We also need to better inform users about the soils within the delineations.

b. Consensus was that maps should be available to all users. Several members mentioned the need for soils maps in various levels of libraries and for a better delivery system for sails maps in progressive soil survey areas.

c. Al 1 contributors commenting on the subject of computer storage of soil map information were in favor of at least some soil map computer data; others thought all soil map computer data should be digitized and made available to users. However, with computerization comes the responsibility of spatial accuracy and accessability, and the program must be designed for update so that a static data bank does not hinder Improvement.

Charge 2. Standards of interpretations of taxonomic or cartographic units.

Recommendations:

1. Continue to coordinate soil interpretations by phases of soil series. We also recommend making interpretations at higher categories of our soil classification system. These interpretations would be less specific than those at the phase of series level. It is necessary that we coordinate any such interpretations at higher categories.

2. The committee recommends that the interpretations from the relatively simple guides such as those used today be put into the soil manuscript. We must also tell the user that the guides and other more specific or detailed interpretations are in local SCS offices.

3. We recommend that soil survey interpretations be made at the county, state, and national level. The greatest need for soil interpretations continues to be at the county level. A point was that we do need to be able to assess problems such as the effect of a 15% increase or decrease in wheat acreage upon production, at the state and national levels. Interpretive maps are especially useful at the broader levels. Computers are necessary for widespread production of such maps.

4. We recommend that update of published soil surveys should be done when new knowledge regarding the response of soils in the survey area makes the survey but-of-date or changes in land use or in kind of intensity of management makes the update of the information necessary for proper interpretation. The soils mapping and correlation should be evaluated at the time of the update of the soil interpretations.

Other Important Comments:

a. A point mentioned in making soil interpretations at higher categories was the improvement to our soil classification system through examination of uniformity in soil interpretations within higher categories. The point was stressed that users must read the mapping unit description. Another point was that we should emphasize that soils mops are for planning and not for site design.

h. The question asked the committee member8 was, "Are our interpretations accurate enough?" Most members thought they were acceptable, but most also stressed the need for continued improvement in gathering data. One of the main points addressed was the timeliness of the soil survey interpretations; because of rapid improvements in techniques and the data base, Interpretations become outdated quickly.

c. Interpretations at the phase of the series level are the kinds of interpretations most commonly used. One member expressed concern about possible confusion by nonsoil scientists in trying to understand interpretations or soils at categories above the series level.

Another point was that the level of interpretations should reflect the intensity of the soil survey; the Idea being that we should not attempt to make the same precise kinds of interpretations for an Order 5 survey as for an Order 1 survey. Other members mentioned the need for more specific kinds of information and there was also the concern that soil scientist,,: continue to get help from other disciplines in making and improving soil survey interpretations.

d. A question from the chairman to the committee members asked if soil interpretation8 should be made from relatively simple guides, such as those used today, a o that nonsoil scientists can interpret them to users or should they be more specific and, therefore, more complicated.

Most members responded with the idea of using the current simple guides that are understandable to a wide variety of users. Several members indicated the need for more specific information, but thought the published soil survey report was probably not the place for this kind of information. Such information would be worked out locally and furnished people willing to take the tfme to understand the concept.8 presented. We do need to tell the user of the published soil survey where to get more specific information. There were several suggestions that we publish the guides for making nonagricultural interpretation6 in the published soil survey or at least make them available.

e. Most members commented that computer storage of soil information, such as on the present SCS-SOILS-5 form, is desirable. A few also thought all soils information should be stored on the computer; even the more complicated soil interpretations, The majority believed, however, that the more complicated information should be used locally. Some thought that soil potentials should be published in the soil survey while other were against this idea because they are not coordinated.

f. This point addressed the problem of what port of the interpretation material available should go Into the soil survey manuscript and how much into the Soil Conservation Service field office technical guide. No member suggested putting all of the Information available into the soil survey manuscript. Most suggested that specific interpretations, such as soil potentiale, fertilizer recommendations, and interpretations undergoing rather rapid change be a part of the technical guide and not the soil survey manuscript.

The idea was expressed by several members that the soil survey manuscript cannot answer all questions and cannot be updated as rapidly as local information. In the future, more users may receive a map and special interpretive information Instead of a soil survey publication.

Charge 3. Standards of correlation.

Recommendations:

1. We recommend that the completed soil survey of each state have an updated correlation. The updated correlation is necessary for a uniform application of soils data, especially at state and national levels. Soil maps should be checked for accuracy when the correlation is updated.

2. We recommend that soil surveys be recorrelated when needed to update the soil survey. The efficient time to update the correlation would be when an adjacent county is being completed and correlated. The field party and the correlator would be available and familiar with the soils of the area.

Charge 4. Soil survey staffing.

Recommendation:

We recommend that soil scientists be retained after the Survey of the United States has been completed to:

a. Remap some soil survey areas at a higher intensity because of land use changes.

b. Maintain the soil data base. This includes supplementary mapping, onsite investigation. making soil survey interpretations and developing new kinds of interpretations.

c. Training - More of the soil scientists' time will be spent training other disciplines about soils.

d. Soil Research - We anticipate that more soil scientists will be Involved in work to understand more about soils such as soil moisture regimes, the relationship of organic matter to pesticides, etc.

Other Important Comments:

a. The state soils staff will likely need about one less member than at the present time.

Soil survey staffing at area levels should be determined by a staff analysis. Some high use counties might require a soil scientist, while low use areas would have a soil scientist for several counties.

b. The soil science job of the future will be very demanding. The soil scientist will need a wide base of technical training. There will be very little routine work.

Discussion and Comments

Committee 1

Larry Wilding - Use classes and **not** hard numbers on the SCS-SOILS-5 form.

Klaus Flach - We can put a statement on the SCS-SOILS-5 that these data are estimates and are subject to change (Talbert Gerald - This secton on the SOILS-5 is headed "Estimated Soil Properties.")

John Rourke - Staffing should be determined by amount of work to do. Washington Office and TSC staffs should also be determined in this way.

Larry Wilding - Old surveys - check composition of mapping units and the landscape relationships to mapping units.

Don McCormack - Need a systematic may of determining where we need more data.

Ed Ciolkosz - We should put all data in computer and see what we have.

Klaus Flach - Need to make recommendations from committee.

Recorder: Talbert Gerald

Committee Members

O.F. Bailey
Hubert J. Byrd
Dr. V. W. Carlisle
*Jack Chugg
*J. R. Culver
Albert W. Hamelstrom
Dr. D. E. Hill
G. R. Landtiser
*Kermit Larson
*Donald E. McCormack
Dr. B. J, Miller
Glen E. Murray
*Joe D. Nichols - Chairman
Dr. G. Nielson
Sidney A. L. Pilgrim
Jack W. Rogers
Donald R. Robertson
*Gerald J. Post
Dr. R. H. Rust
H. Raymond Sinclair

*Attendance at conference

Attachment to Committee 1 Report

The following changes in Part I of the National Soils Handbook are required to implement the recommendations of Committee 1 of the National Technical Work Planning Conference of the National Cooperative Soil survey. January 21-February 2, 1979.

Charge 1, Recommendation 1
No change in policy is necessary for this recommendation.

Charge I, Recommendation 2
The policy for this subject has not yet been published in the National Soils Handbook. It should be a part of the policy when that part is issued. This would require the operation of the automated mapping system (AMS).

Charge 2, Recommendation 1
Interpretations at higher categories of the soil classification system are allowed in the National Soils Handbook. We need botter guidelines on interpretation of such categories in Part II of the NSH. The recommendation that WE coordinate any such interpretations requires a change in Part 1, Section 605.1. In the last sentence, remove the statement, "soils named from categories in the taxonomy higher than the series."

Charge 2, Recommendation 2
The continuation of interpretations from the relatively simple guides such as those we use today in the soil manuscript requires no change. The recommendation that we tell the user that such guides and other more specific or detailed interpretations are available In local SCS offices should hc placed in thr soil survey manuscript, The information would seem to belong in the "How to Use the Survey" in the beginning of the published soil surveys.

Attachment to Committee 1 Report

Charge 2, Recommendation 3

The recommendation that soil survey interpretations be made at the county, state, and national level requires that we have information on the kinds of soils for each applicable level. One of the first items needing completion is the mapping unit use file for older published soil surveys. This would allow information about kinds of soils for all correlated soil surveys. This should probably be accomplished with a bulletin, since it would be a one-time operation and should probably allow a two year completion date. Information on uncompleted counties will have to come from soil sampling and should be a port of the LIM program. There is nothing in the Soils Handbook on Part I, 700, Land Inventory and Monitoring and it may not be the policy to place such material there. In any event, inventory and monitoring guidelines could point out that county reliable inventories of counties without completed soil surveys would allow predictions of the kinds of soil in those areas. When added to the mapping unit use file, we would then have an inventory of the kinds of soils in the United States. We would not know whether or not those soils were cultivated or what use was being made where the information came from the mapping unit use file. Perhaps a longtime goal should be to store the published soils maps in a national system such as AMS as in recommendation 2 of charge 1. Hopefully, land use from sntellitc data could overlay those areas and predictions of kinds of soil with land use could be retrieved from such a system. As LIM sampling proceeds, information on the quality of the soil and changes would be available. There would need to be a plan allowing use of the information at county, state, and national levels at appropriate offices. County information is available in many instances now. State information for some states should be the next goal. with national information available in certain categories at this time. More detailed information for state and national levels should be a part of a master plan.

Charge 2, Recommendation 4

The recommendation was that published soil surveys should be updated when new knowledge regarding the response of soils in the survey area makes the survey out-of-date. Part I, Section 201 of the National Soils Handbook has not been issued yet, but needs to include a section on our policy to update published soil surveys when it is issued. Section 301.4 on soil correlations does issue policy that soil correlations will be maintained in an updated manner for published soil surveys. Part I, Section 605 of the National Soils Handbook on supplemental reports mentions the kind of supplemental reports recommended. The last sentence of this section states that if all or most of the mapping is revised the soil survey area should be handled as a new soil survey. I recommend adding a statement that up to 10 (or 20) percent of a soil survey may be remapped without handling the soil survey as a new soil survey area. If examination of the soil survey requires the recorrelation of several soil series and appreciable update in kinds of soil interpretation, consideration should be made to a republication of the soil survey and the maps. In cases where very little, if any, remapping are needed, supplementary soil reports provide the most economical system of furnishing soils information.

Charge 3, Recommendation 1

Is a recommendation that the completed roil rurvey of each state have an updated correlation. Thin in the policy now stated in Part I, Section 301.4 of thr National Soils Handbook. 1 recommend adding to the National Soil Survey Handbook, item 103, part 1(a), The completed soil survey of the United States will include an updated correlation and updated interpretetions for each soil survey area. When Part II, Section 301.6 on naming mapping units and Section 301.4 on eoil correlation are issued, they should contain sections on updating end correlating of older published surveys.

Charge 4, Soil Survey Staffing

The National Soil Survey Handbook, Part I, Section 206 needs to include a statement on evaluation and uee of older published soils surveye when that section of the National Soil Survey Handbook la issued.

The following changes in Part II of the National Soils Handbook are required to implement the recommendations of Committee 1 of the National Technical Work Planning Conference.

Section 203, Evaluation and Use of Older Published Soil Surveys

This section needs to be developed. Charge 2, recommendation 4, charge 3. recommendations 1 and 2, and charge 4 recommendations are related to this subject.

Section 205

This section needs amending to show procedures for evaluating older published soil surveys and older soil mopping that was never correlated. The present section is an explanation of how to do a survey for the first time.

Section 206.3(a)(3), Priority of Areas for Soil Surveys

Add an item 3 to the third sentence (3), "Areas where older mapping requires evaluation as to adequacy."

Delete the word "both" before the (1). Add after the third sentence: Survey areas should not be removed from the list of modern soil surveys until re-evaluation is complete and a cooperative agreement is written to do the necessary work,"

Section 406, Coordinating and Testing Soil Survey Information

When this section is written it ahould allow for coordination of interpretations for higher categories in the taxonomy. Note that instructions are complete for storing the interpretations at higher categories on the SOILS-5. In addition, there is no instruction in the NSH that we not put such Interpretations in soil survey manuscripts. We do not place interpretations at higher categories in tables in manuscripts because of a letter or phone call several years ago. We need to think about this. I think the trouble that caused us to stop putting this information in tables was that some people were interpreting the units like phases of soil series instead of properly as phases of higher categories. Section 407.1(a)(2)(ii) allows for the entry on a SOILS-5 of Suborder, Great Croup, Subgroup, Family or Family Phase.

NATIONAL TECHNICAL WORK PLANNING CONFERENCE
OF THE
NATIONAL COOPERATIVE SOIL SURVEY

January 29 - February 2, 1979

Committee 2:

Use of soil family class in design of mapping units.

Charge: Evaluate the adequacy of using the soil family class as the principal components of mapping units for soil surveys in areas used primarily for range or forestry.

Committee Action: An outline was prepared by the chairman, posing questions to which the members of the committee could respond. This outline was distributed on October 2, 1976. About 3/4 of the committee responded, some briefly and some extensively. A summary of the responses was prepared by the chairman and this was sent to the members of the committee for review and comment on January 2, 1979. Some comments were received prior to the work-planning conference.

The committee met as scheduled, discussed the charge and the responses and prepared a report for the conference.

Summarized Report:

The committee found it necessary to clarify and narrow the charge. As we responded to the charge as it was given to us, we found ourselves talking about different things at the same time -- and we were poles apart. The charge says "soil family class." Some, then, were thinking of the entire class and others were thinking of phases of families. Further, the charge says "soil surveys in areas used primarily for range or forestry." But not all forest lands in this country arc alike. The same can be said for range lands. Some committee members immediately thoughtof the 2nd order soil surveys being made in some of the heavily forested areas of the Northwest and elsewhere; others thought of 3rd order soil surveys in various parts of the country; others were at the same time thinking in terms of the 4th order surveys that have been made in Nevada and elsewhere.

Naturally, the responses became somewhat tangled. Therefore, we decided to narrow the scope of our deliberations and to state our assumptions.

In comparing the use of soil families with the use of soil series as the principal components of mapping units it is assumed that:

(1) the soil survey objective as stated in the work plan is the same in each case

(2) the same order of soil survey in being made (3rd order)

(3) the same scale of field sheets is being used

(4) phases of soil families are being compared with phases of soil series

A. An analysis of possible advantages of use of the family class

1. Contrary to what some have believed, cartographic detail is not significantly decreased by shifting from phases of soil series to phases of soil families. Rarely are adjacent mapping units composed of members of the same family. More commonly they are composed of members of different subgroups or great groups. Thus. the lines on the field sheets would likely be in the same places whether we used phases of soil families or phases of soil series. Cartographic detail is influenced more by other factors such as mapping unit design, scale of field sheets and complexity of landscapes.

2. Total time required to complete a soil survey may be shortened by use of phases of families. The main factor is the time saved by not needing to identify, describe, define, classify and establish soil series. In areas where the series are well known in adjacent or similar areas, the difference in rate is less significant.

3. The same basic principles of soil correlation as defined in the National Soils Handbook apply whether soil series or soil families are the components of mapping units. Quality control is very important regardless of the kind of names used for the mapping units. Some soil correlation time is saved by not Processing soil series. The committee emphasized the need to provide adequate documentation of both taxonomic units and mapping units.

B. Problems identified in the use of the family class

1. The soil family as a category in Soil Taxonomy is too broad for use in most 3rd order soil surveys. The desired interpretations require refinement to phases of families.

2. Systematic procedures for transfer of information from one soil survey to another have not been developed for soil surveys using the soil family class as the reference term in the mapping unit name.

3. Soil family class names are bulky, awkward and cumbersome to use as components in the names of mapping units. Use of the

common names for families shortens the names but is considered to be misleading by some users. Some families that cover very large geographical areas should have 2 or more series names selected for the common names of the family. Identification of common names is incomplete.

4. Present procedures using the SCS-Soils-5 form and tables generated by the computer are not geared to use of the soil family.

5. Lag in notification of additions of new soil families can result in duplication of effort in proposing new families and series to go with them.

C. Potential solutions to problems involved in use of the soil family

1. The phases of families provide sufficient information on which to base interpretations in many 3rd order soil surveys. In some mapping units it may be desirable to use reference terms named for categories above the phase of family level but this should be done only if such mapping units then satisfy the needs set forth at the beginning of the soil survey.

2. No solution was discussed.

3. No fully acceptable solution to the naming problem is identified at present. The option should be given to use either the common name of the family or the family class name. Steps are being taken to ensure that all families, except mono-series families, have 1 or more series names selected for use in common names for the families.

4. The committee agreed that the SCS-Soils-5 form needs to be (a) modified to meet the needs of soil surveys using phases of families as components of mapping units or (b) replaced by a separate form. SCS-Soils-6 forms would be nodificd to conform to the changes in the SCS-Soils-5 forms.

5. Printouts of placements of series in Soil Taxonomy should be mailed directly to cooperating agencies rather than to state offices of SCS for distribution to cooperating agencies. The interval between printouts should be as short as possible. Frequent printouts of changes in placements would be helpful.

D. Advantages of the use of the soil series

1. The soil series provides more detailed information on soil characteristics important to range and forestry operations such as surface soil characteristics, soil temperature. soil moisture, rock fragment composition, depth to bedrock, depth to sand or gravel, nature of parent materials, presence of root restricting layers, characteristics of water table and drainage and soil reaction.

2. Nomenclature of mapping units is simple and established.

3. Procedures are available for transfer of data.

4. Computer-generated interpretation tables are readily available.

5. The series is currently well known and accepted by users.

E. Problems with use of the soil series

The main problem Identified by the committee is the time, money and personnel required to identify, describe, define and process soil series. However. the committee did not favor attempts to make the concept of the soil series more flexible.

F. Possible solutions to problems dealing with the use of soil series. The preparation and processing of soil series descriptions could be streamlined. The committee did not exhaust the possibilities for doing this but suggested the following as a start.

1. Explore the feasibility of adapting computer assisted writiny techniques or related techniques to the preparation of series descriptions.

2. Continue to test tabular writing techniques.

3. Train party leaders in proper methods of preparing series descriptions. Properly prepared initial review drafts facilitate review at all levels.

4. Correct the misconception that the requirement for a minimum of 10 pedon descriptions for each new soil series means that all must be complete descriptions to be acceptable.

Discussion and Conclusions:

Most of the committee agreed that there are many advantages to using phases of series in 3rd order soil surveys and encourage their use when time and budget constraints allow. However, the use of phases of soil families is acceptable as long as these meet the stated objectives of that particular soil survey. It appeared from the work of the committee that the phases of soil families currently being mapped in several areas differ little from phases of soil series mapped in other survey areas.

Recommendations:

A multi-agency task force be assigned by the Assistant Administrator for Soil Survey to work out procedures so that phases of soil families can be used effectively in the soil survey. The assigned tasks to include:

1. Modify SCS-Soils-5 or develop a similar form.

2. Modify SCS-Soils-6, if necessary.

3. Develop a system to allow transfer of data.

4. Evaluate phase naming conventions for soil families. Recommend additional phase names and criteria, if needed.

Committee Members:

Charles Goudey, FS, San Francisco, California
Edmund Naphan, SCS, Reno, Nevada
Laurence D. Giese, DNR, Olympia. Washington
Phillip S. Derr, SCS. Casper, Wyoming
William L. Braker, SCS, Bozeman, Montana
Douglas S. Pease, SCS, PHoenix, Arizona
Shelby H. Brownfield. SCS, Boise, Idaho
William U. Reybold, SCS. Washington, D.C.
LeRoy de Moulin, BLM, Denver, Colorado
Henry B. Waugh. BIA. New Mexico
B. F. Hajek, Auburn Univ., Alabama
Glenn E. Kelley. SCS. Kentucky
Harlon R. Finney, SCS, Minnesota
E. C. Westin, S. D. State University
Arthur D. Kuhl. SCS, Pennsylvania
Richard L. Guthrie. SCS. Fort Worth, Texas
Robert I. Turner, SCS, Lincoln, Nebraska
Louis L. Buller. SCS. Lincoln, Nebraska
L. M. Richlen, FS, Missoula. Montana
J. Ellsworth Brown, SCS, Portland, Oregon - Chairman

Questions and Discussion:

Jim Talbot - What do you envision would be eliminated from or added to the SCS-Soils-5 form?

Keith Young - When soil families are used, some soil properties are not as well defined. Therefore, we may not be able to be quite as precise in our interpretations.

Larry Wilding - Some of our families are very broad. But a phase of a family seems to be about the same as a soil series.

J. E. Brown - In some of our current surveys there is little difference between the phase of a soil family and the phase of a series.

Klaus Flach - This may end up to be two different ways to arrive at the same product.

Jim Dement - Would a representative pedon be written? Yes.

Don McCormack - What kind of case studies have been made to analyze the relative costs of the two kinds of soil surveys?

J. E. Brown - A detailed study was made In Nevada by the Soil Conservation Service and the Bureau of Land Management. This study was intended to help BLM decide whether to use soil series or soil families in soil surveys on ELM land. They chose soil series. (See "Comparisons of Soil Families vs. Soil Series, Order 3 Soil Inventories, Nevada BLM-SCS" prepared by Bureau of Land Management, Nevada State Office, with assistance from BLM, Elko District and Soil Conservation Service, Nevada State Office and SCS Elko Field Office, February 1978.)

National Technical Work-Planning Conferences
of the Cooperative Soil Survey
January 29 - February 2, 1979
San Antonio, Texas
Report of Committee Number 3 - Surface Horizon
Characteristics Under Different Conditions

CHARGE

The characteristics of surface horizons arc related to the ease of seedbed preparation (cultivated soils), plant emergence. soil erosion, infiltration of soil moisture, and others. These characteristics may change during the year. There is a need to observe and record information about surface horizons at different times of the year so that changes in these characteristics can be recorded.

Terminology and definitions nced to be developed to evaluate properties of surface horizons that affect land usc both when cultivated and uncultivated. Properties include: crusting, soil temperature, ease of wetting, cracking, granulation, stability of clods, structure, evidence of biologic activity, periods when wet, moist, dry, etc.

MEMBERSHIP

R. R. Allmaras, SEA-AR; Pendleton, OR
P. E. Avers, FS, Atlanta, GA
O. W. Bidwell, Kansas State University, Manhattan, KS
S. Buol, North Carolina State University, Raleigh. NC
R. B. Campbell, SEA-AR. Florence. SC
R. M. Cruse, North Carolina State University, Raleigh, NC
J. W. Doran, SEA-AR, Lincoln, NE
R. W. Fenwick, SCS, Davis, CA
D. W. Goss, SEA-AR. Lincoln, NE
C. S. Holzhey, SCS, NSSL, Lincoln, NE
G. I. Huntington, University of California, Davis, CA
W. E. Larson, SEA-AR, St. Paul, MN
H. I. McKim, Army Corps of Engineers, Hanover, NH
W. D. Nettleton, SCS, TSC, NSSL, Lincoln, NE
Fred Petterson, University of Nevada, Reno, NV
L. F. Ratliff, SCS, Auburn, Al
O. W. Rice, SCS, Broomall, PA
Jim Richardson, North Dakota Stale University, Fargo, NO
M. Scilley, SCS, St. Paul, MN
E. L. Skidmore, SEA-AR, Manhattan, KS
O. M. Van Down, Ohio Agricultural Research and Development Center, Wooster, OH
R. A. Young, SEA-AR, Morris. MN

INTRODUCTION

Wc prepared a "first draft" state-of-the-art report concerning surface horizon characterization. Emphasis was given to both observations and measurements that can be made by soil classification personnel in the field, as well as measurements in the laboratory.

The state-of-the-art report was divided into sections and Committee members prepared statements.

A summary of the state-of-the-art report along with specific recommendations follow:

SOIL MATER

1. Matric potential-water content relationships.

The report summarizes current methods of measurement very well. Matric potential-water content relationships at low potentials in cultivated soils are highly dependent upon bulk density. Because the physical conditions in cultivated surface horizons are so dynamic. a measurement of matric potential-water content in the laboratory may have limited applicability. For many purposes the water content at a specific matric potential can be estimated satisfactorily by Lhc equation,

$$\theta p = a \text{ sand} + b \text{ silt} + c \text{ clay} + d \text{ OM} + e \text{ BD}.$$

The coefficients a. b, c, d, and e need to be developed fur each potential. Further, they will prohably need to be developed by taxonomic classification, such as Suborder. Data may be available in the Lincoln laboratory.

Recommendation: Use Gupta and Larson's (1978) regression technique for estimating soil waler retention curves for soils whet-c measured values arc not available. Establish regression coefficients by Order or Suborder.

2. Infiltration.

Parameters closely related to infiltra tion in the field are soil roughness (microrelief), plant residue cover, desiccation cracks, and macropores.

The English Soil Survey Field Handbook classifies roughness as (a) furrowed, (b) mounded, or (c) fla ttened. Research me thods for measur ing roughness include measurement of the surface soil el evation on a 5-cm y-id over a 100- x 100-cm area. The eleva lions are corrected for land slope and culliva tion marks and a random roughness index calculated which is the standard error of the difference in elevations (Allmaras, et al., 1966).

Cover of the soil with plant rosiducs influences soil water, temperature, arid other soil properties. For both soil water and soil temperature the percent soil surface cover is needed. Percent surface cover can be measured directly or estimated from weight measurements (Sloneker and Moldenhauer, 1977).

Grossman (1979) suggests that gross surface cracks be defined as having a surface width exceeding 2 mm and into which a 2-mm diameter wire can be inserted 15 cm by a force less than the force it would take to insert the rod 1 cm into the weakest fabric through the 15-cm zone. For the purpose of this definition, the soil surface is taken as 5 cm below the actual surface if there is a surface cultivation mulch. Definition is needed as to how to express the frequency of cracking.

A fourth important parameter is the occurrence of micropores by earthworms and other soil organisms. This is discussed under the section on Biodynamics of Soil Structure.

Recommendations:

a. Estimate soil roughness with pinboard technique (details of of measurement and expression of data need to be worked out if methods of Allmaras et al., 1966, are too time-consuming).
b. Measure gross surface connected cracks (see Grossman).
C. Measure surface plant residue cover by line transect method (details are being developed).
d. Estimate macropores by methods in new soil survey manual.

3. Saturated and unsaturated conductivity.

Clapp and Hornberger (1978) presented some empirical regression type equations based on moisture retention curves fur estimating soil hydraulic properties. Using this technique they divided soils into 11 textural groups and computed the hydraulic parameters. In the absence of measured moisture retention curves. estimated moisture retention curves of Gupta and Larson (1 979) may be used. Estimation might be improved by considering only a given taxonomic unit such as the suborder.

Recommendation: Explore Clapp and Hornberger's method for estimating hydraulic conductivity.

4. Soil water repellency.

The report summarizes the current literature and methods of measurement of water repellency. Water repellency, or lack of it, can be used as a significant diagnostic. The suggested field test for water repellency is as follows. A single drop of water is placed on a soil surface dry enough that a dry color can be read. Record persistence as weak repellency if less than 5 seconds is required for water penetration, moderate repellency from 5 to 60 seconds, and strong repellency as greater than 60 seconds.

Recommendation: Estimate wdter repellency for all soil mapping units using the method described above.

SOIL TEMPERATURE

The detailed report summarizes the literature on factors influencing soil temperature and means of estimation. Soil temperature of surface horizons can be measured directly or estimated by regression type techniques which consider such parameters as air temperature, wind speed, solar radiation, soil water content, soil thermal conductivity, and plant or residue cover characteristics. Unless immediate surface temperature (<1 cm) are needed, we feel that soil temperatures can be computed satisfactorily for most purposes using regression techniques. Regression models for estimation of coil temperature arc available from SEA-AR, St. Paul, Minnesota.

Al bedo is a property of the soil Lhat influences Lhe temperature of the soil signi ficantly, and is a required parameter in many estimation equa Lions. Soil color is closely related Lo albedo. Therefore, it is suggested that wet and dry soil color be measured in the field on all surface soils. If the soil surface is covered with an orgnic mulch layer (crop residues), the wet and dry color of lhc mulch should also be noted. The percent cover of the soil surface should also be measured by the line-transect method and the type of residue noted.

Recommendation: Record wet and dry soil and residue Munsell colors. For residue color. note time of year.

SOIL STRUCTURE

1. Soil factor for soil loss equation.

The soil factor (K) for use in the Universal Soil Loss Equation (USLE) is widely used. fhc K-factor has been measured on a few selected soils and factors for other soils determined by committee estimation or by nomograph or regression techniques.

Because the K-factor is at best an estimation, it would seem that the K-factors could be assigned to a taxonomic family. Then all soils in the family would have the same K-factor. This would simplify computer calculations. A problem arises where different K-factors are assigned for different horizons in the soil series.

No recommendation at Lhis time.

2. Wind erodibil i ty index.

The wind erodibili ty index (I) for use in the wind erosion equation has been determined for only a few soils. At present, I values For other soils are estimated based on texture and calcium carbonate content of the surface soil.

The I-value is derived from Lhc weight percentage of soil aggregates less than 0.84 mm in diameter. It can be determined in the field by dry sieving, al though more accuracy is obta ined under standard conditions in the laboratory. But the I-value is transient, and it may be that it can be estimated by other means more accurately than a single field measurement.

Recommendation: It is suggested that researchers, soil classificationists, and agronomists explore the possibility of assigning I values to taxonomic units; perhaps the family. Means of assignment would have to be worked out.

3. Bulk density.

Bulk density of the surface soil in cultivated fields Is a dynamic property. It is the result of many mm-made and natural forces. Bulk density estimations of surface horizons cnn be made by a variety of methods. At present the saran-clod (or similar) technique is widely used. A simple excavation procedure developed by R. B. Grossman for measuring bulk density in very loose cultivated horizons appears promising.

Regression type equations which consider particle sire distribution, organic matter, and calcium carbonate contents have been developed and can be used to estimate hulk density to within 0.1 to 0.2 g cm^{-3}. The estimation can be improved if the regression and estimation is limited to a taxonomic unit or horizon.

Two developments appear worth further exploration. These are being followed up by Dr. R. R. Grossman of the Lincoln laboratory, SCS. One deals with a laboratory measured soil compression model. This procedure developed by SEA-AR in St. Paul (Larson et al., 1979) is now being tested in the soil mechanics laboratory in Lincoln. The procedure gives an estimation of the bulk density as influenced by applied stress and is a quantitative measure of the soils' susceptibility to compaction. A packing model has also been developed by SEA-AR in St. Paul (Gupta and Larson, 1979) which may be useful in describing the potential for soils packing to high bulk densities. Input to the model are particle size distributions and organic matter content. The usefulness of this model is also being explored by Dr. Grossman. The model predicts a minimum, maximum, and "normal" bulk density for a given horizon.

Recommendation:

a. Make soil compression measurements in the laboratory on selected soils and check laboratory values against field measurements. If the results arc inagreement, make soil compression a standard laboratory measure.
b. Explore use of Gupta and Larson's (1979) packing model for estimating bulk density range.

4. Usefulness of consistency and soil strength in soil interpretation.

We recommend no changes to the consistence measurements as outlined in USDA NO. 436 and in the usual Atterberg tests. We recommend use of a penetrometer for field classification because of its simplicity and usefulness of the data. However, standard procedures need development.

No recommendations at this time.

5. Aggregate stability.

Most techniques devised to estimate aggregate stability apply an unmeasured force, or a measured force applied without knowledge of exact transfer involved, to single or groups of aggregates. These techniques, if applied in 'a uniform manner, provide reasonable estimation of relative stability of the samples tested, but the results cannot be used quantitatively to simulate the real world in the field. Shear and compression tests are probably the most quantitatively transferable to the field. Aggregate stability is transient for a given soil, although there are probably ranges of differences for widely different soils.

Recommendation: At present we do not recommend any aggregate stability measurement other than the "visual" or "feel" system now used.

6. Soil crusting.

Soil crusting in the field is an important phenomena that influences runoff, erosion, seedling emergence, and other soil behavior. However, crusts in surface horizons are transient. Probably what is wanted is a measure of the soils' susceptibility to crusting or sealing.

Various means of measuring crust strength are available in the laboratory.

Recommendation: A quantitative field measurement of soil crusting or the susceptibility to crusting is not recommended at this time. We do recommend use of the English Soil Survey Field Handbook system, which classifies soils into (a) unslaked, (b) partly slaked, and (c) slaked. Definitions for surface cracking have been prepared by R. G. Grossman.

7. Biodynamics of soil structure.

The complete report summarizes well the importance of microbiological and macrobiological activities on the soils' physical properties. It points out that organism activity is highly dependent upon food supply and environment. In the laboratory, organism counts, and biochemical and enzyme assays can be made and related to various soil parameters. Farthwotm counts, casts, or tunnels can be made in the field. Notes on other macroorganisms can also be made.

Biological activity in the soil (particularly earthworms and plant roots) creates macropores. These macropores are important channels for water flow.

Recommendation: Estimate macropores by methods in new soil survey manual.

REFERENCES

1. Allmaras, R. R., R. E. Burwell, W. E. Larson, and R. F. Holt. 1966. Total porosity and random roughness of the interrow zone as influenced by tillage. USDA-ARS Cons. Res. Rept. No. 7, May 1966.

2. Clapp, R. B., and G. M. Hornberger. 1978. Empirical equations for some soil hydraulic properties. Water Resources Res., Vol. 14, No. 4. August 1978.

3. Grossman, R. B. 1979. Personal communication. Lincoln, Nebraska.

4. Gupta, S. C., and W. E. Larson. 1979. A model for predicting packing density of soil using particle size distribution. Soil Sci. Soc. Am. J. (In press),

5. Gupta, S. C., and W. E. Larson. 1979. Estimating soil water retention characteristics from particle size distribution, organic matter percent, and bulk density. Submitted to Soil Sci. Soc. Am. J.

6. Larson, W. E., S. C. Gupta. and R. Useche. 1979. Compression of agricultural soils from eight soil orders. Submitted to Soil Sci. Soc. Am. J.

7. Sloneker, L. L., and W. C. Moldenhauer. 1977. Measuring the amounts of crop residue remaining after tillage. J. Soil and Water Cons. 32(5): 231-236.

NATIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

January 29-February 2, 1979
San Antonio, Texas

Report of Commitee 4 - Water Supplying Capacity Of Soils for Different Plants

Charge

The amount of water available to plants depends on climatic factors, physiographic position, and waterholding capacity of soil including the effective depth of storage. What data are available and what are needed to better evaluate water storage and supply capacity of soils.

MEMBERSHIP

Olin D. Bockes, SCS, Washington, DC
R. R. Bruce, SEA; Watkinsville, GA
John B. Carey, SCS, Albuquerque, NM
Terry D. Cook, SCS, Davis, CA
L. A. Daugherty, New Mexico State Univ., Las Cruces, NM
T. B. Hutchings, SCS, Salt Lake City, UT
Paul R. Johnson, SCS, Lincoln, NE
Paul 0. Kresge, Montana State Univ., Bozeman, UT
Ronald Kuhlman, USDI, Bureau of Land Mgt., Washington, DC
Douglas D. Malo, South Dakota State Univ., Brookings, SC
Robert T. Meurisse, Forest Service, Portland, OR
Milton W. Meyer, JR., SCS, Washington, D. C.
Lloyd N. Mielke, SEA, Lincoln, NE
Franklin Newhall, SCS, Lanham, MD
Ronald F. Paetzold, SCS, Lincoln, NE
R. V. Rourke, Univ. of Maine, Orono, ME
Keith E. Saxton, SEA, Pullman, WA
Robert H. Shaw, Iowa State Univ., Ames, IA
Willard M. Snyder, SEA, Athens, GA
Howard M. Taylor, SEA, Ames, IA
Wallace W. Wilhelm, SEA, Lincoln. NE

Robert B. Grossman, Committee Chairman
USDA, Soil Conservation Service
National Soil Survey Laboratory
Federal Bldg.-U.S. Courthouse, Roam 393
Lincoln. NE 68508
Comm. No.: (402) 471-5363
FTS No,: 541-5363

INTRODUCTION

The report consists of a body and a set of Documents. The body contains a set of recommendations which are amplified upon individually in the Discussion section. The Documents provide the background for the body of the report. Committee members were asked to select and respond among the topics listed below:

Subject	Documents Pertaining
Field soil water data . .	.10, 11
Relation of short- and long-term weather records,	8, 11
Field water state evaluation in range 0.01-15 bar	
Simple procedures. . . .	7, 12
Sophisticated monitoring stations. . .	7, 10
Interrelationship with remote-sensing efforts.	. 7, 11

Hydrologic modeling. . . . .
Root distribution and water extraction by roots. 2, 3, 4, 5, 11
Definition of available water and interpretive tables. 1, 6, 11
Taxonomic description of the moisture regime 9, 11

Much of the work was on root evaluation, sources of field soil water data, and on presentation of water information in the interpretations program. Little work was done on the interrelationships with hydrologic modelling and in the assembly of procedures for the field measurement of water in the available range. This committee relates closely to Committee 6, in the area of description of the pattern of soil water states through the year. The connection is because a description of the pattern of water states would contain information on available water present during the growing season.

RECOMMENDATIONS

Roots

The Problem: Most states do not document quantitatively the rooting depths of the phases used to define mapping units (Document 2). Root abundance classes of the current draft of the revised Soil Survey Manual are at variance with research (Documents 4, 5). Editorial policies for publication of root information reduces its usefulness.

Recommendations:

A. Make part of standard soil survey documentation generalized observations on the deepest extension of both common roots and few roots for at least two index crops per Major Land Resource Area.

B. Adopt the recommendations implicit in Document 5 for the root abundance classes in the new Manual. Include Instructions in the Manual on the differences in application for monocots versus dicots.

C. Use the Dutch specification, namely, that the base of effective rooting is the depth above which 80 percent of the total root length occurs.

D. Include the date of observation and the crop (plants) in published pedon descriptions if root depth information is given. Define terms such as "effective rooting depth," "root zone," etc.

Implementation:

Establish a small group of workers on roots to advise the NCSS. The group should include workers on tree rooting.

Current Available Water Estimation

The problem: Available Water Capacity (AWC) currently is based on a laboratory Water Retention Difference (WRD) modified by ideas about how morphology or composition reduces (for example, through root restriction) or augments (for example, through textural change) the WRD. These guidelines are not codified nationally. We have come too far to drop AWC and switch to WRD, and quite probably we should not, because the plant inference involved in the adjustment from WRD to AWC is healthy.

Recommendation:

E. Report an Available Water Capacity (AWC) in our interpretative publications based on a nationally applied set of adjustments from the assumed Waler Retention Difference (WRD).

Implementation:

Include a set of guidelines for conversion of WRD to AWC in the National Soils Handbook. Provide an explanation of the conversion assumptions for the report in the Glossary of the soil survey report. Document 1 is illustrative of the kind of national guidelines required but is not complete (salt concentration for example is not treated).

Laboratory Water Retention Measurements

The Problem: The 1/3-bar retention is generally accepted as too high a tension for estimation of field capacity and there is an accelerating need for enough desorption points to construct curves for calculation of unsaturated hydraulic conductivity among other applications. However, we have a large investment in 1/3- (1/10) bar retention data. Furthermore, it is not possible in the Federal portion of the NCSS to get more retention points given our present resource allocation to physical pedology unless we were to cut back considerably on the number of samples.

Recommendation:

F. Urge member NCSS laboratories to shift from the determination of 1/3- (1/10) bar on all horizons completely characterized to the determination as a minimum of 0.05, 1/3, and 2 bar on a portion of the horizons. On the other horizons, only bulk density and 15-bar water desorption points would be measured. The other tensions would be estimated. The National Soil Survey Laboratory should allocate resources to prepare rapidly guidelines for the estimation of 0.05- and 2-bar retention.

Implementation:

The National Soil Survey Laboratory should initiate changes along these lines.

Water-Related Information in Interpretation Documents

The Problem: The information on soil water in soil survey reports and other application documents is scanty and has insufficient emphasis on plant growth. Although water state calculations are done for taxonomic placement and will be done probably in the drought prediction effort, they are not done in standard soil survey interpretations.

Recommendation:

G. Provide a table of water-related data for soil phases of mapping units in standard soil survey reports and in interpretation documents for soil classification units that includes rooting depth estimates and application of a hydrologic model to predict dry days or a similar number to depths related to the root depth information.

Implementation:

Document 6 is an example. Flexibility in content among MLRA's would be encouraged. We should explore use of the Saxton hydrologic model among others for calculation of the number of days.

Assembly of Field Water Measurements

The Problem: There is a considerable body of field measurements of water state over time (Document 10). This information stands largely outside of the data base of NCSS. The new Manual probably will suggest norms for series documentation that to be fully realized would require application of this information. Taxonomic questions such as the paralithic contact definition are closely related to pattern of water removal by plants.

Recommendation:

H. Make collection and publication of field soil water state information a principal responsibility of an SCS employee for 1 year, after which consider the transfer of the responsibility to the Soils Units, Technical Service Centers. Possibly center the activity initially at the SEA-AR Hydrologic Data Lab, Beltsville.

Field-Determined Maximum Water Content Range

The Problem: A number of investigators feel that the direct determination of the range in water content, related to a probablistic statement on the precipitation during the year(s) of measurement to the long term average, is more useful than laboratory water retention as a basis for available water capacity estimates (Documents 7 and 8).

Recommendation:

1. If the information has not been obtained already (Recommendation G), begin Lo collect and assemble data on the field determined maximum range in water contents. Begin to incorporate a plant available water number into the interpretation program that uses the laboratory water retention at low tension or an estimate thereof for the maximum water content and the minimum field water content for the lower limit if above 15-bar retention and the soil is drier than usually moist and lacks a water table within 2 m.

Implementation:

Assistance is needed on guidelines on limitations of the technique because upward water movement is important. Include measurements at O-5, 5-15 cm (or thereabouts) where feasible to provide information for evaluation of remotely sensed water, cultivation zone variability, surficial horizon temperatures, and mulch effectiveness.

Taxonomic

The Problem: The present definition of the moisture control section is cumbersome Lo apply and excludes the uppermost part of the soil in which for soils with a large component of the total precipitation from small storms during the growing season much of the total roots are concentrated. The present criterion for the moist-dry separation is largely non-operational for other than aridic (torric) roils because the minimum water content approaches but does not go below 15 bar.

Recommendation:

J. Define the thickness of the taxonomic moisture control section on the summation of WRD (L1xWRD1 + L2xWRD2 + L3xWRD3 = 8 cm). Move the upper boundary to thr soil surface. Set "P subsections of O-10 cm and from JO cm Lo "here the total WRD fro,,, the soil surface is 8 cm. Use 0.8 timer 15 bar for the lower water content for the calculation of WRD for soils that are either aridic (torric) or intergrades thereto. Except for the separation of aridic (torric) soils from others, change the criterion for separation of moist and dry states from 15-bar retention to a higher water content (if sandy, 15 bar + 2 weight percentage points; others, 15 bar + 1/4 of WRD).

Implementation:

We request that Dr. McClelland's taxonomy committee consider the proposal.

Annual Sequence Water States

The Problem: The current draft of the revised Manual does not require subdivision of the "moist" class during the growing season within the zone of major rooting. The records, therefore, would he of limited value for the application of Lhe charges of this committee.

Recommendation:

K. Require in the proposed annual soil-water sequence for the revised Manual that during the growing season there is a record for each month to a depth of I meter or to a root limiting zone if above 1m of the proportion of the Lime the zone is upper moist, (or some such tern,), defined as a stare when the water content exceeds the ? of the 15-bar estimate and the following proportions of an assumed WRD, where the family particle size classes pertain to the fine earth and coarse fragments are excluded: sandy, 4/5; coarse-loamy, 3/4; fine-loamy, coarse- and fine-silty, 1/2; clayey, 1/4. Consider substitution of 2-bar retention for these guidelines as soon as estimates are generally available.

Future Activities

Soil water undoubtedly will be a topic of the next meeting. The topic is technical, many faceted and central to our interpretations program, which in the future probably will receive proportionately more attention in these deliberations. There is a need now Lo enlist the help regional committees and to focus time and energy on a few topics that will be explored at the next meeting. It ix recommended that:

The Washington Office shortly establish working groups that would become a committee for the next NWPC. The working group would enlist the help of the upcoming regional work-planning conferences to pursue:

(a) Improvements in the definition of root abundances classes, frame guidelines on description of crops which differ in root abundance, work on field procedures, and assemble rooting depth information.

(b) Apply existing water regime data to complete an annual water stale sequences for a major soil phase for each MLRA, if the data are available. This recommendation would stand apart from whether annual water state sequences are in the revised Manual, since in one form or another we need a standard format for Lhe assembly and display of water regime information.

(c) Explore the application of unsaturated hydraulic conductivity measurements for standard pedological documentation, for interpretations, and as applied Lo hydrologic models. Recommend procedures.

(d) With both the enhanced activity in remote sensing of waler, which is restricted now to the upper few centimeters, and the greater interest in the application of pedology for agronomic purposes, it seems appropriate to work on the uppermost part of Lhr soil. The working group would explore various aspects of the yearly pattern of water states of the uppermost 5 to 20 cm of Lhe soil as this relates to remote sensing, cracking, local variation in row-cropped fields, soil mulch effectiveness, and interrelations to runoff and erosion.

DISCUSSION

The section parallels and amplifies upon the recommendations of the previous section and provides a link Lo the Documents.

Document 2 reviews the documentation of roots in recent standard soil survey reports. Thr information generally is scanty and commonly is wanting in quantitative exactness. It would seem a low apple to improve the situation greatly. There would seem to be "a teal technical impediments. Guidelines (to be suggested) should be established shortly and applied in the ongoing soil survey quality control program. There is, though, a further matter. The soil survey is largely completed in many Major Land Resource Areas. For these MLRA's, we would collect root information by phone and correspondence from experienced soil scientists independent of the quality control program of ongoing soil surveys. A" initial procedure to get some information rapidly, might be for the Soils Staffs, TSC's, Lo assign MLRA's Lo states, and to request the states to give best estimates for the dominant phase of the soil series named in the mapping ""its of the general soil maps of thr completed soil surveys of that MLHA. We need, in any event Lo get the joh done soon to capture the experience of people who have mapped in these MLRA's.

Possible guidelines for data collection on a survey basis are as follows:

For two index crop plants (trees included) in the Major Land Resource Area where the survey is located, provide estimates for each soil phase of the depths (to the nearest 10 cm) to the base of common or many roots and to where roots essentially stop. Provide depth limits for both irrigated and nonirrigated soils if considerably different. Select index crops on the basis of extensiveness, ubiquity, and economic importance. If valid field water depletion information is at variance with the maximum depth of rooting, then substitute a depth based on the water depletion information. Provide in the soil survey report in tabular form the descriptors indicative of strong root restriction and explain. Indicate in the generalized discussion (tabular, hopefully) of the mapping unit that no coots would be expected because of these root' restricting features. Document 3 shows as an example that for important soils of Major Land Resource Area 103 presence of sand and gravel and massiveness instead of weak structure are highly correlated with where roots stop. Hake root observations an important consideration in selection of pedons for quality control documentation of soil phases. Do not make root observations a particularly important criterion for inclusion of a pedon in the published soil survey. Concentrate on root depth generalizations in published Documents.

Adopt Howard Taylor's: recommendation on classes of root abundance (Document 5): This would require changes in the current draft of the revised Soil Survey Manual (Document 4). Make an evaluation of within-horizon root restriction from the soil surface for horizons with few roots. A possible approach is lo have three claaaea: No restriction, some rratriction, and nearly complete restriction. For the last class, caaentially all roots would he between structural units or in permanent voids or pores. For the "some" and "complete" restriction classes, provid a number related to the size of soil volumes that are nearly free of roots. Thia number might be taken as the minimum diameter of volumes from which roots arc reatrirtcd. It would be assessed by a transect normal to the planes of maximum root concentration (vertical if between plates, horizontal if between prisms). The median distance would be established for the diameter of volumes from which routs are excluded. The total transect length should be at least 10 times the final median value.

Current Available Water Estimation

No discussion.

Laboratory Water Retention Measurements

Selection of 0.05 bar is based on these considerations:

(1) 1/3 bar should be kept as one of the determinations because of the large amount of data. Accepting this, it is advantageous to have a tension considerably lower than 1/3 bar.

(2) 0.05 bar is low enough that rather rapid field measurements are feasible using a tensiometer.

(3) English physical pedologists use 0.05 bar for a laboratory ealimate of the upper water content for available water rapacity measurements.

(4) Field measurements (Document 7), particularly for surficial horizons, indicate that the upper water limit considerably exceeds that retained against 1/3 bar.

(5) Measurements hy the chairman suggest that the minimum tension at 15 cm when farmers cultivate is below 1/3 bar.

The 2-bar determination is the lowest tension at which desorption measurements generally can be run on samples disaggregated to pass 2mm; a lower tension would he impracticable because a natural fabric sample would be needed and resultantly because of the thicker sample the equilibration time would be greatly increased.

As a data base for 0.05 and 2 bar is developed, estimates would be given in soil surveys and in other phases of the interpretation program.

Water-Related Information in Interpretation Documents

The table (Document 6) would include single value estimates by grouped horizons of permeability, proportion of the matrix and structural surface with < 2 chroma (optional by MLRA), 1/3- and 15-bar water retention and available water by horizon groups; bulk density and volume of coarse fragments if not in another table; depths to the bases of common roots and of few roots; a measure of the relative moistness or dryness over the depth of common roots using perhaps the soil taxonomy estimator program; runon and runoff class placements; thr seasonal high position and kind of Water table; hydrologic group; and flooding Incidence. Last three would be as entries for the phase.

The chroma would be useful in certain soils for predicting the seasonal occurrence of free water. Retention values would provide numbers, not adjusted for plant use, that may find application in such things as computation of air-filled pore apace and determination of the amount of water energetically available to plants at a given field soil water content for irrigation scheduling. Computation of the number of dry days in the month of highest evapotranspiration over the depth to the base of the common roots combines available water, evapotranspiration, and precipitation. The example employs the procedure developed by Franklin Newhall, Climatologist, SCS (Calculation of Soil Moisture Regimes from the Climatic Record. Mimeo. 1976). Seasonal high water table now part of the standard documentation. Runoff and runon classes have to be defined. 'The idea would be to list those soil phases where there is sufficient runoff or runon that there is an important impact on the internal soil moisture. For such soil phases, calculation of water state from precipitation and evapotranspiration (dry days, for example) would not be reported.

The advantage of such a table is that we would have in one place much of the information that pertains to the water regime. By this assembly we would reinforce interrelationships and provide more of a focus on plant growth considerations.

Assembly of Field Water Measurements

In 1964 the chairman (then also chairman!) requested information iron, the state soil scientists (Document 10). Recently, the chairman made inquiries by phone, mainly to SEA-AU personnel, and also requested the committee members Lo supply information. The recent survey (Document 10) is incomplete. A rough estimate is that 200 taxa-vegetation records were uncovered in the recent survey that should be explored for possible Incorporation in the national data base.

These figures do not include work begun in 1979, the ESCS program, various remote-sensing studies, the dryland wheat stations, and California work (surveyed hy a committee member). Neither does it include data found in the 1964 survey which was no, uncovered in the recent survey. We may assume that a complete survey would double these figures, but that this increase would be offset by half of the taxa plus vegetation combinations being unsuitable for one reason or another. For planning purposes, then, a figure of 200 taxa-vegetation combinations may be assumed. A" estimate of 10 weeks travel is assumed to visit the major installations. The work itself would take at least 1 year of concentrated effort after which it could be turned over the the Regional Soils Staffs to continue. The assembly should be so arranged that personnel oi the originating organization are authors on the port ion of the publication that contains their data. The first efforts should go into hard copy publication. One reason is that the data would be accessible Lo the most people the quickest. Another reason is that a format could be adopted, using separate sections by originating office, which would give explicit authorship to the people and organizations from which the data originated. A third reason is that the various limitations and complexities of the data set can be explored and explained. It would seem that the Hydrologic Data Office, SEA-AU, Beltsville, would be a good place for a person to work on the project since there is already the infrastructure for the interpretation and publication of hydrologic information. Furthermore, the encumbent could associate with Lhe people nearby in the National Soil Correlation and Classification Offices.

Water state data assembly is only part of a more general need to assemble hard-to-get, expensive water data. Such data include free waler height and movement; hydraulic conduct ivity. saturated and unsaturated; and infiltration.

Field-Determined Maximum Water Content Range

Document 7 contains methods proposed try Ritchie, et al., and also by the chairman. Documentat ion of the precipitation for the period of measurement is important as is comparison of the short-term and long-term precipitation records in order to establish the relative wetness or dryness over the time of measurement (Document 8)

There is a question about the validity of the lower water limit in soils where there is appreciable upward movement of water. Document 7 conta ins a paper on a study in which upward movement of water is measured. A small difference between the upper and lower limit at the base of the zone of water depletion may be the result of upward water movement and not be a consequence of a small removal of water by roots. As a rule of thumb, upward movement may be assumed to be small for soils that are drier than usually moist if free waler is below 2 meters. Perhaps the method may be applied to most soils in the area of usually moist soils if they lack I, water table above some depth. The subject needs more consideration.

Special attention needs to be given to the collection of field water contents for the upper 5 to 20 centimeters of the soil. This zone commonly is quite different from the soil beneath in composition and organization. In row-type cultivated fields the organization is strongly dependent on the degree and the kinds of mechanical disturbance. Water contents in parts of the surficial zone that are not compacted are highly sensitive to tension in the range below 100 mb. The upper water limit as determined in the field (Document 6, Franzmeier, et al.) may be considerably higher than 1/3-bar retention for surficial horizons. Laboratory water retent ion measurements at low tension on such surficial material are scarce because of the difficulty of collecting samples. Minimum water contents may be useful in the prediction of the loss of waler by surface evapotranspiration. Remote sensing of water is limited lo the upper 5 to 20 centimeters. We should obtain ground truth for the minimum water content of the uppermost few centimeters linked to a probabilistic statement relating the precipitation during the measurement period lo long-term precipitation (Document 8).

Taxonomic Matters

Document 9 contains comments about the moisture control section with regards to the thickness and boundaries. Based in part on the discussion in Document 9, three changes are proposed: The first is to place the upper boundary of the control section at the soil surface. The reason originally for not placing the upper boundary at thr surface was to remove the effect of small precipitation events that would not have much influence on plant growth and would reduce the reliability of calculations of the soil moisture stale from weather data. Field measurements now are more common, and there is less need to calculate the moisture regime from weather data. Furthermore, remote sensing techniques to measure the upper few centimeters are al hand, nnd we should rake advantage of them for taxonomic placement. Perhaps the most important reason to change is that the part of the soil excluded is of critical importance for a wide range of soil behavior inferences.

The second recommendation is lo have two subsections, from 0 to 10 cm to a depth sufficient to hold a specified amount of water. The O-10 cm subsection would be employed in the definition of the moisture regime of soils drier than usually moist that lend lo have shallow rooting. Such soils commonly have an appreciable component of summer precipitation.

The third recommendation is to definr thickness of the lower subsection on centimeters of waler held between 1/3 (0.1, 0.05) bar end 80 percent of 15-bar for soils where the question is whether aridic (torric) or not, and 15-bar for the other soils. Such a definition would be much easier lo apply than the current one (difference between depth of penetration of 1 inch and 3 inches of water.) If the upper 10 cm were excluded, the control section should have a capacity of 8 cm of water. If the control section were placed at the surface, the rapacity should be 10 cm. The RO percent of 15-bar approximates 100-bar retention.

The fourth recommendation involves the use of 15-bar as the criterion for the separation between moist and dry states. This is unsatisfactory for the separation of soils that are only somewhat drier than usually moist because these soils unless they crack strongly, except in the extreme upper parts, have minimum waler contents very near 15 bar. The reason is 'hat adapted plants remove water only to near 15 bar. For such soils, it is impossible by field techniques to establish whether they are dry or moist. The matter needs study. Perhaps a couple of limits are needed with water content increasing as the taxonomic boundary in question becomes more moist.

The current draft for the description of the yearly sequence of soil water states (which is a subject of committee 6) makes it optional whether Lhe slightly moist and very moist subclasses of moist are used. The moist class encompasses more than the range of water normally considered available (0.01-15 bar vs. 1/3 or 1/10 or 15 bar). Hence to say the soil is moist, Rives little information on amounts of available waler. To implement the charge of this committee it would seem obligatory to provide more precision than is possible using the class moist alone. The requirement to use subclasses of moist could be restricted Lo the upper meter and to the growing season in order to reduce the work and still have a data base highly relevant to plants.

Other Matters

Document 11 raises the concern that, more attention should be give,, to the water state below the moisture control section. It is the chairman's though1 that we should give the moisture regime description proposed for the new Manual (the charge of Committee 6) several yearn Lo become applied before considering the issues.

This report overall puts emphasis on field observelione and measurements (roots, measurements of maximum and minimum waler content, documentalion of water states over time, etc.). This reflects the chairman's hiss, committee membership, and the direction of lhr soil survey, which is a very emperical activity. There is another viewpoint, which favors emphasis on deduction of the water regime from weather data snd measurements of soil properties. Keith Saxton, SEA-AR, Pullman, Washington, very ably presents this position:

"For the SPAW model (Saxton, et al, 1974. Trans. ASAE 17:673), I need to know the water holding characteristics of the roil by each major horizon. This consists of tension-water and unsaturated conductivity-water relationships plus values for saturation, field capacity, and wilting point. For J recent study involving use of the model over broad areas of Missouri, Kansas, Iowa, and South Dakota, I used soil texture descriptions to select from a series of generalized water characteristic relationships which we developed from literature data. This method, with all of its simplifications and assumptions, proved to be quite useful for computing soil water regimes and relating these to crop water stress end crop yields."

". . . I see little use of measuring existing soil water. We first need the basic soil properities then we can integrate the climatic and vegetation effects. If soil water monitoring is done, extensive variable measurement is needed to document the climate, soil, and vegetation effects if any explanation or extrapolation is to be accomplished.

"Hydrologic ❑ odelling will use data inputs of all of these factors and allow them to interact with time. Soil characteristics are one of the most important but they vary less with time so they add stability and predicatable performance through time for a given location.

"Root distribution with time end depth is very important since this is the primary connecting method between soil water in storage and climatic evaporative demand. The complexities of root penetration, densities, aging, and effectiveness certainly need much more definition and relationships to the soil profile.

"Descriptions of plant available water should come from the roil water characteristic curves. I believe if we had 'adequate' descriptions of the soil water relationships, particularly tension-water curves, we could then relate these to plant availability for the characteristics each plant possesses to abstract soil water. This again says to focus our attention on the soil and not the vegetation interactions.

"In summary, my comments are biased toward J physical soil water approach. But to advance, 1 strongly believe we need to focus primarily on physical soil descriptions as we now find them existing, then integrate the climate and vegetation effects for explaining the soil which has developed over time and for predicting the water regimes and vegetation growth."

To a degree, Saxton is saying that the roil survey should do more hydrologic modelling. We currently are applying two hydrologic models in the NCSS generally. One is the model for the calculation of water regimes for taxonomic placement developed by Franklin Newhall; the other is curve number approach for runoff which includes placement of soils in hydrologic groups. The effort in hydrologic ❑ odelling in Lhr NCSS would seem too small. There is no way to test Saxton's posit ion on the relet ive emphasis on emperical measurement or deduction but Lo apply one or more hydrologic models widely. The current taxonomic model is simple compared to several other hydrologic models in use. Do we have the necessary input data to test the use of more hydrologic complex models for taxonomy? Apparently the SCS drought monitoring stations (Document 10) would gather the necessary data. Should we apply more complex models to the interpretive documentation for soil surveys (see Document 6)? Could the effect of slope and aspect on radiant energy received be added to models such as Saxton's SPAW? Meurisse has a model that includes these data (Document 11). Perhaps NCSS should list what output is desired from a model and request SEA-AR to recommend which of the available models to apply by MLRA. Apart from which hydrologic model is applied, until we have the staff and experience to apply models widely, we are not going to have an evaluation of the very important question that Saxton raises. Perhaps indeed we should not expand our efforts at field water collection, but concentrate on roots, water desorption and unsaturated hydraulic conductivity.

COMMENTS

Flach: One intention in forming this committee was to consider the integration of rainfall, crops, and crop needs. Nave different soils and different plant needs. A given circumstance may affect the same crop differently on different soils and affect different crops on the same soil quite differently. Furthermore, we seldom have an average year.

Grossman: We would like to test the Newhall model and also more complex models for our interpretations program.

Finch: Want something the user can use. How do we apply the model?

Grossman: Document 6 is illustrative. Should be different for different MLRAs.

Harris: We have difficulty evaluating available water in Vertisol. How do you handle bulk density?

Grossman: Bulk density of Vertisols is 1.2 to 1.4.

Harris: Ritchie's work shows a bulk density of 1.9.

Grossman: He is measuring the bulk density of the dry clod.

Wilding: You are taking gravimetric weight percent as a way to estimate water. Cracks become nonsoil. How do the Dutch define the base of plant rooting?

Westerveld: To answer Dr. Wilding, this is a kind of practical tool from field observations without hard data. Lower boundary of root zone is depth that includes 80 percent of roots. I will send more information.

Kimberlin: You are following a reasonable path but be sure to get the information into a form the user can understand and use.

NOTE: Copies of the following background material can be obtained from the National Soil Survey Laboratory in Lincoln, Nebraska

Documents Section - Committee #4

"Water Supplying Capacity of Soils for Different Plants"

NATIONAL TECHNICAL WORK PLANNING CONFERENCE
OF THE
NATIONAL COOPERATIVE SOIL SURVEY

COMMITTEE 5: CONFIDENCE LIMITS FOR SOIL SURVEY INFORMATION

I. COMMITTEE MEMBERSHIP:

* Dr. F. P. Miller, Co-Chairman
* Dr. L. P. Wilding, Co-Chairman

Dr. R. W. Arnold	Dr. R. L. Handy	*Dr. E. M. Rutledge
* Dr. Ray Dideriksen	* Dr. B. L. Harris	*Mr. Charles Thompson
* Mr. William J. Edmunds	* Mr. Victor G. Link	Dr. Goro Uehara
Mr. Frederick E. Gilbert	* Mrs. Heleaine Markowick	*Mr. Earl E. Voss

II. OBJECTIVES:

1. To develop procedures for defining the confidence limits of soil properties commonly observed and Inferred in the construction of soil surveys of a given area. Reliability of this information should be considered in terms of the mapping unit definitions, scale of mapping, probable user clientele and soil behavior.

2. To develop formal and informal vehicles to better communicate the applicability and limitations of soil surveys for prospective user clientele.

3. To identify research, educational, and service needs chat should be continued or initiated to better achieve the above objectives within short-term and long-term prospectives.

III. STATEMENT OF PROBLEM:

Soil surveys are being used increasingly by a more sophisticated clientele. Many users are familiar with statistical indicies and now request confidence limits and variability parameters be presented with data and information provided to them. In transmitting information and interpretations of soil behavior via maps and tables. the soil scientist is being pressured to provide confidence limits and measures of homogeneity to document the authenticity of soil surveys. Among many users there is still a sense of mystique about soil surveys; how are they made and what is their degree of predictability under constraints of mapping-unit composition variability and in incredibly small sampling size of the whole landscape?

Soil survey reports do not adequately provide the user with on understanding of how the soil scientist extrapolates inferences from observations on the landscape to points beyond where these inferences are judged to be valid. The points at which the inferences no longer apply become the boundary of mapping unit delineations. The scientific basis of soil surveys is that soil conditions do have a predictable pattern of association with a given landscape.

* Members present at National Workshop in Son Antonio. Texas 1979

Therefore, to use the soil survey effectively and within its confidence limits. the user must be aware of the scientific philosophy, techniques and basis for: making soil maps, the composition of resulting landscape mapping units. the variability of both mapping unit components and associated soil properties, and sources of error in constructing a soil map. When a user of soil survey information does not possess this understanding, it is the responsibility of the interpretation specialist and report writer to transmit these concepts clearly to the user so he places no more nor no less confidence in the product than what is intended.

IV. **APPROACH RATIONALE:**

Membership to this standing committee is interdisciplinary in scope; individuals have been invited to serve on the basis of their expertise, interest nnd experience to contribute to the objectives set forth. Responses to initial activities have been excellent and individuals hove taken their commitments seriously. This report necessarily represents a status report of past activities and future endeavors.

Work groups were assigned to assemble preliminary information regarding confidence limits that could bc expected from soil surveys fur properties identified as determinants for soil response behavior to applied uses. The following format was followed for committee input:

1. Identify soil properties including depth nnd other attributes (i.e., pnrcnt material, bedrock geology, topography, climate, etc.) that affect use and management of soils for given purposes.

2. Identify sources of error and relative magnitudes encountered in construction of soil surveys relative to above properties (i.e., cartography, mapping scale, mapping procedure, definition of mapping units and pcdon sampling errors).

3. Identify means to gather additional information where voids become evident in the data base.

4. Identify communication vehicles to relate knowledge of confidence limits to users.

5. Draft consolidation report and recommendations.

Initial efforts will concentrate on items (1) and (2). After the pertinent soil properties have been identified, the work groups will scale sources of errors that affect estimation of these determinants from soil survey information.

V. CASE EXAMPLES - PROBLEMS. SOIL PROPERTIES. SOURCES OF ERROR AND MANAGEMENT THAT AFFECT SOIL INTERPRETATIONS

A. Waste Management:

1. Problem: Waste management includes the loading of the soil medium with and the renovation of liquid effluents from domestic septic systems, septage, animal wastes, a variety of sludges from municipal waste treatment plants, secondary treated liquid effluents from domestic waste treatment, solid wastes and other wastes without environmental and health impacts. Soils vary in their capacity to handle such wastes. Loading and renovation are functions of several soil and land attributes.

2. Important soil properties and land attributes influencing waste management:

   a. moisture regimes
      1) permeability or hydraulic conductivity; saturated vs. unsaturated flow
      2) soil behavior with respect to hydrologic cycle; amount of throughflow, lateral flow, storage, ET, and surface runoff.

   b. soil volume
      1) amount of suitable medium
      2) depth to slowly permeable horizon or water table.

   c. environmental factors
      1) plant growth related
      2) adsorption capacity, chemistry (CEC, pH)

3. Sources of error:

   a. map scale vs. system size; i.e. septic system small enough to flt into inclusion whereas large scale effluent spray systems covers many acres.

   b. depth constraint on information; knowledge base and degree of predictability for soils decrease with depth. even though degree of heterogeneity of substrata varies from landscape to landscape.

   c. hydraulic conductivity is inherently a highly variable property, especially unsaturated K.

   d. soil behavior is, system-dependent; loading and renovation are a function of type of system, i.e., shallow septic system vs. deep dry well system vs. surface irrigation system vs. overland runoff system, etc.

4. Recommendation:

   An expanded discussion of the most commonly used systems and their behavior and causes of failure could enhance the user's confidence in soil survey interpretations.

B. Soil Corrosivity:

1. Problem: Metallic and nonmetallic materials are used to transmit a variety of resources, electric currents. and messages. Many of these materials are buried in the soil medium. These materials are also used to anchor and support structural loads within the soil. The longevity and strength of these materials are often a function of their susceptibility to electrochemical and chemical attack. Soils vary in their potential to corrode these materials. Corrosion is a multibillion dollar a year loss to the American taxpayer and consumer.

2. Important soil properties and land attributes influencing mettalic corrosivity:

   a. availability of moisture to form electrolyte.

   b. permeability of soil to moisture and oxygen (redox potential; anaerobic/aerobic environment).

   c. variability of electrolyte and oxygen with time, spatial distribution and depth.

   d. type of metal and degree of solubility of corrosion salts.

   e. amount of exchangeable and soluble ions, especially S04, Cl, and exchangeable acidity (resistivity-conductivity).

   f. presence of sulfur oxidizing and reducing bacteria.

3. Sources of errors: Since corrosion is a function of changes in soil. environments (temporal, spatial, depth) and frequency of changes in soil unit size and contrast; error sources include:

   a. inadequate characterization and description of properties causing corrosion .

   b. inadequate indexing of contrast between soil "nits (causing electrochemical cells due to different electrolytes and degrees of oxidation) and between soil horizons as influenced by both depth and time (e.g. fluctuation of zone saturation).

4. Recommendation: Where interpretations are made for corrosivity, there should be an expanded narrative section explaining the other attributes and conditions that can produce concentration cell electrochemical potentials beyond just soil properties. Such a discussion con provide the users with enough information to make their own interpretations based on map unit contrast, etc.

C. Crop Production:

1. Problem: Because of the need for more precise management decisions necessitated by the cost/price squeeze faced by today's farmers and the increasing value of cropland, because of the potential impact of production resources on water quality, and because of the increasing demand for defining, delineating, and designating prime

farmland, production indices and yield data are needed.

2. Important soil properties and land attributes influencing crop production:

   a. solar radiation, day length, temperature, seasonal character

   b. water supplying capacity (rooting volume) and availability (climatic vs. ground or surface storage)

   c. nutrient supplying capacity

   d. permcobility to both water and oxygen (drainage)

   e. trafficability

   f. erodability (slope, K factor)

   g. susceptability to salinization

3. Sources of error:

   a. management variability

   b. climate

   c. crop variety

   d. tillage systems (lower yields with lower production costs may provide higher prof It)

   c. crop systems (fallow. etc.)

   f. variability of rooting volume (e.g., impact of erosion on crop production - do not do adequate job of presenting topsoil depth in map descriptions)

4. Recommendations:

   a. systematic yield data acquistion should hc considered; Extension agent, SCS district conservationist, and experiment station personnel should be gathering yield data before and during progressive soil survey.

   b. consider production index rather than specific yields for map units in soil survey.

   c. provide more information on soil rooting and production characteristics of mapping unit.

D. Mineral Resources:

1. Problem: Soils can be used as indicators of underlying mineral deposits (e.g., sand, gravel, topsoil, limestone, bedrock aggregate, etc.) where these resources occur at shallow enough depths to impart parentage characteristics to the soil profile. For many of these

resources, however. their depth beneath the soil precludes the use of the soil as an indicator of their presence.

2. Important soil propertics and land attributes influencing mineral resource identification:

   a. mineral resources are often specific to geomorphic units (e.g. gravel terraces, eskers, etc.) associated with specific soil or soil sequence.

   b. other mineral resources prcdictnble only on narrow physiographic basis.

   c. depth and homogeneity of soil parent material can provide high confidence level of predictability.

3. Sources of error:

   a. depth and homogenity of soil parent material often not known below 5-6 feet. (e.g., 7-foot loess cap over gravels).

   b. confidence levels can and must be limited to specific geomorphic units and narrow physiographic basis for many resources.

   c. sands, gravels predictable bnscd on geologic deposition (energy gradient) sequence; therefore. soil science is often not the appropriate discipline to provide a predictive basis for mineral resources.

E. Range Management:

1. Problem: Range site is an ecological unit and should be synonymous with soil mapping unit. There is little difference in accuracy requirements in mapping rangeland than other intensive kinds of surveys. Mapping units can and should conform to natural landscape units that coincide very closely with range sites. The philosophy of a range site, however, varies with personnel.
2. Important soil and range site conditions influencing range management:

   a. plant community composition - kind and proportion of dominant species.

   b. biomass production of the plant community

   c. soil rooting volume characteristics (texture, root depth, bedrock type, permeability, bulk density, mineralogy, minor elements, salts, carbonates, gypsum).

   d. climate - macro and micro

   e. landscape unit attributes (aspect, relief topographic form, etc.)

f. available water supplying capacity - integration of items c thru e.

3. Sources of error:

a. Cartography - very little. map scales appropriate, mnp quality generally good

b. Soil survey procedures - small error

c. Definition and composition of map units - major error; comcepts change over time; rapid turnover of soil scientists in area; map units inadequately defined; inconsistent interpretation of definitions by different scientists.

d. Inadequate means to relay knowledge of confidence limits to users.

4. Recommendations:

a. Need better documentation of confidence limits of mapping units.

b. Need more comprehensive definition of mapping units.

c. Need better means to transfer knowledge of sources of error and confidence limits to users.

VI. APPROAHCES TO DETERMINI: CONFIDENCE LIMITS OF UNITS SAMPLED

A. Binomial Confidence Limits Approach - Cornell

1. Background: Graphs of accuracy or confidence limits versus sample size are exponential, clumsy to use and hard to read,

   Dr. R. W. Arnold and associates of Cornell University have developed a graphics1 solution to binomial confidence limits. The utility of this approach is bused on observations that are mutually exclusive. A series of linear curves for different members of observations. probability levels and classification accuracies have been developed as a simple, rapid means to statistically summarize transect and other mapping unit composition data into confidence statements defining component soils and properties. This procedure particularily lends itself to recognition or establishment of boundary limits for class concepts. It is less useful in recognition of central tendencies of observed class phenomena.

   The graphical approach illustrated by Arnold is linear and sufficiently simple that it could be applied by most field soil scientists (see Figues 1 - 2 as examples). Merits of the approach include:

   a. binomial decisions are the basis for most soil survey activities.

   b. graphical solutions allow emphasis on interpretation of data for confidence limits rather than laborious statistical calculations.

   c. graphical solutions allow field men immediate feedback from data collection.

   The graphs produced use the number of ground truth observations on the Y axis and the number of "other than" class members on the x axis. The "other than" class members represent those observations that do not fit within the limits of the class concept. The levels of accuracy (maximum = upper confidence limit and minimum = lower confidence limit) are shown as straight lines and interpolations can be made between them. The estimates obtained by this graphical solution are more than adequate for our purposes in soil survey.

2. Use of confidence limits: When classes that are mutually exclusive are considered the decisions about any one class membership constitute a binomial experiment. An observation either belongs to the class of interest, or it belongs to some other class. It is included or excluded; it is a yes or no decision.

   In making probability statements. trade-offs are involved. For any set of observations, one can vary the chances of being wrong (probability level) or one cnn vary the limits of accuracy (degree of correctness). It is always a compromise. If you want to be really confident of your statement (say only 1 chance in 100 of being Wrong), the limits will be very wide. On the other hand, if you like to gamble (1 chance in 5 of being wrong), then the stated limits will be very narrow. If a somplc is truly representative of a larger population, then hy increasing the number of samples the limits will become narrower, For example, if we measured all pedons in a map unit we would have a perfect fit and the answer would be absolutely correct. Graphs can be prepared for any level of probability. Likewise each graph can be prepared for a number of snmplc sizes. The two examples that follow are for the upper and lower confidence limit using the 90% probability level and for sample sizes up to 50.

A lower confidence limit lets you make an at least stotcmcnt. When you make 40 observations and 10 belong to other classes, the measured percent is 75% and graphically you note that at least 62% is estimated to be the some class (1 in 10 chance of error).

An upper confidence limit lets you make an at most statement. With rho previous example you note that at most 83% is estimated to bc the same class.

All too often we report only our guesstimate of the proportion found in a sample or suspected of being found. It is more realistic LO give ranges based on the sample data at our disposal. Every decision we make is based on our preception of the correctness of the information and on our preception of the risk or expected consequence of making this decision versus an alternative decision.

3. **How many samples to take?** The minimum number of observations to make varies with the chnnccs of being wrong (probability level) and the level of accuracy (degree of correctness) desired.

The graphs for the lower confidence limit can be used to estimate how many samples will be needed. Set probability at 90% and assume you want your estimate to be at least 80% accurate when applying the sample results to the rest of the map unit. Follow the 80% line for minimum level of classification accuracy down to the Y axis where there are 0 "other than" class members and you note 14. This means 14 random observations would he needed if all belonging to the same class, that is 14 out of 14. If you expect, or find, 3 observations that belong to other classes, then go to 3 on the X axis and vertical till you cross the 80% accuracy level and over on the Y axis where It indicates a need for about 38 observations. That is, with 35 out of 38 obscrvntions belonging to the same class, you will expect an 80% accuracy of the major component.

Another woy to think about samples Is when you plan to take 200 samples (observations) then you must not have more than about 27 observations in other classes if you hope to achieve at least on 80% accuracy.

4. **Estimating composition:** The purpose of statistical probability is to let you extrapolate from observations drawn from a sample to the population as a whole. For example, you often wish to extrapolate from measurements made in a few delineations to map unit as a whole.

Assume you made 4 transects having 13, 9, 7 and 11 observations for a total of 40. Out of that 40, only 30 belonged to the same class. The predicted maximum accuracy would be about 83% and the minimum accuracy would be about 62%. You, therefore, would estimate that the map unit comprises between 62 and 83% of the major component based on your set of observations and assuming a 1 in 10 chance of being wrong. Estimates of each component can be obtained from the graph, or if necessary, by extending the graph if you maintain the same intervals on both the X and Y axis.

This same procedure applies to consociations, complexes, and associations. It also applied to other features such as stoniness, rock outcrop, and in as many ways as you have binomial decisions to make.

B. Analysis of Variance (ANOVA) Approach - VPI

1. **Introduction:** There is a move afoot nationally to introduce the statistical method into the characterization of mapping and taxonomic units in soil survey. The statistical method provides procedures for assessing the magnitude and distribution of the existing variability in a mapping unit to different levels of sampling. A random sampling approach to this pursuit is advanced by W. J. Edmunds of VPI.

It is argued that selection of pedons for characterization and failure to randomly replicate observations limit statistical analysis of the data to simple descriptive statistics, such as mean, standard deviation, variance, standard error, and coefficient of variability. These statistics describe the distribution of a population about an average for a given parameter. It is further argued that statistical statements based on these variables are limited to only the pedons observed and may not be applied to the entire mapping unit since pedon selection produced a fixed effect. The lack of replication of observations and of an experimental design prevents an analysis of the variability of a mapping unit. The use of coefficient of variability as an estimate of variability in a mapping unit can lead to misleading conclusions if covariance occurs between sample mean size and standard deviation (S.D.). Table 1 illustrates such a situation for base saturation.

Table 1. Base Saturation by Strata for Napping Unit 105C1 Montgomery County, Virginia

	CV	$\bar{Y}$	S.D.	MIN	MAX
Stratum 1	47.1	45.4	21.4	13.1	79.2
Stratum 2	55.6	8.2	4.6	2.2	15.5

If soil science is to comprehensively assess the variability within mapping units, it follows that the use of statistical analysis of variance (ANOVA) is a powerful tool. ANOVA provides a procedure for determining whether pedons or delineations are similar or different at a given probability level. The use of ANOVA for determining the variability within a given mapping unit can be accomplished by using a nested sampling design since a pedon can occur in only one delineation. However, mapping units can be compared by using a factorial design within nesting.

The application of ANOVA necessitates that current sampling procedures be changed from selection of sites for characterization to a complete randomization of samples from:

(1) Strata within a soil association.

(2) Delineations within strata.

(3) Pedons within delineations.

(4) Replications within pedons (within 7m).

The use of a mixed effect, nested ANOVA design to characterize a mapping unit in Montgomery County, Virginia has been tested.

This soil association in Montgomery County, Virginia, "as stratified and sampled randomly according to a nested ANOVA design. The terrain in each stratum was analyzed by computer for the parameters of elevation and relief and for the percentage distribution of slope classes and topographic shapes. The variance "as partitioned and calculating formulas and assumptions have been provided in the statistical design.

2. Summary :

The use of ANOVA and the partitioning of the total variance into error (variability within 7 meters), pedons (within delineations). delineations (within strata), and strata (within soil associations) locates the source of variability in a mapping unit. If the major portion of the variability is within and among pedons within delineations, a complex of two or more taxonomic units may be used to describe the mapping unit. When the variability is among delineations within strata or among strata, an undifferentiated group of two or more taxonomic units may be used to describe the mapping unit. However, if the major portion of the variance is among strata, two mapping units may be used.

Results from this case study in Virginia indicated that the major sources of variability for base saturation, pH and clay content were among strata, pedons within delineations and among duplicate pedons

Extreme variability within mapping units should not be used as the sole basis to evaluate the validity , quality or accuracy of the soil survey product because variability is a criterion for defining the mapping unit in terms of: consociations, complexes, undifferentiated groups and soil associations.

A statistical procedure that enables a better partitioning of relative sources of variability with nnd among mapping units nte pertinent to establishing a mapping unit legend, defining map unit composition and designing experiments for accessing soil behavior.

The major advantage of the ANOVA approach is that it provides unbiased estimates of both central tendency and confidence limits. Disadvantages ate that it requires a mote comprehensive understanding of statistics, results may be confounded by interactions that make interpretations difficult and the method does not readily lend itself to rapid analysis and data reduction by field soil scientists. Another 1 imitation is that it requiter a large number of observations to obtain a uniform distribution of observations over the area of investigation.

C. Coefficient of Variability Approach (CV) - Texas A&M

One approach 1.. P. Wilding and others have found useful to portray variability among different soil properties and sampling entities is the coefficient of variability (CV). CV is a statistical measure of sample variation and is defined as sample deviation (S.D.) expressed as a percentage of the sample mean ($\bar{X}$), i.e.:

$$CV = \frac{100\ S.D.}{\bar{X}}$$

It is appropriate for comparing dispersion of different soil properties free from scale factor but it assumes normal˜ Ltequency distribution, no covariance between the sample mean and S.D. and data where the mean does not approach 0. IL has been convenient to us" CV in comparing data from different experimental sources when comparisons were not possible by other methods because sample designs were different. Figures 3. 4 and 5 ore examples of this approach to illustrate relative magnitudes of soil property variation with increasing scale factor (pedon ⟶ series ⟶ mapping unit ⟶ survey area). These examples represent a compilation taken from the literature and the authors' work but are heavily weighted to glaciated sectors of the world.

If one has site-specific information on probable soil variability or evidence of CV from closely related work, then a practical application of this approach is to estimate the number of samples that must be observed or measured to achieve a given level of accuracy (confidence level) at a stated probability level. Figure 6 graphically relates CV and the number of observations necessary to obtain confidence levels of ± 10% and ± 20% of the true population. These curves assume a 95% probability level (1 chance in 20 of being wrong).

While it is not possible to generalize soil variability for all conditions, certain soil properties consistently tend to be more variable than others. Examples have been categorized as follows:

1. least variable properties - CV's commonly < 15%
   - soil color (hue and value)
   - soil pH
   - thickness of A horizon

2. moderately properties ________ - CV's commonly between 15 and 35%
   - total sand, total silt and total clay separates
   - CEC
   - base saturation

- grade and class of soil structure
- liquid limit
- calcium carbonate equivalent

3. most variable properties - CV's commonly >35% and sometimes 100% or more for some chemical properties (see Figure 3)
   - solum thickness
   - B2 horizon thickness
   - soil color (chroma)
   - depth to mottling
   - depth to carbonates
   - exchangeable cations
   - fine clay content
   - organic matter content
   - plasticity index
   - hydraulic conductivity

In all of the above approaches considerable committee deliberation was spent on discussing sample schemes (completely random, randomly-oriented point-transects and prealigned or randomly placed grid designs). There was no general consenses of the best sampling method, but the committee recognized that different bio-physical conditions, specific objectives to be achieved and time or labor restrictions would impact on this decision. Several sampling schemes should be developed to satisfy alternative needs.

VII. SOURCES AND RELATIVE MAGNITUDES OF ERROR RELATED TO SOIL SURVEY PROCEDURES AND VERIFICATION

A. Cartography and Soil Survey Procedures

1. Introduction: Pedology is based on working models that attempt to explain the relationships between sets of soil properties and relative landscape positions. One expression of these models is a soil survey map.

   Although most properties or qualities may be considered as continua, experience and tradition in soil survey divides them into classes. Some of them appear to be well founded, and others are somewhat questionable. Nevertheless, the fact that we use classes requires us to consider both centrality and limits.

   Inherent in the sources of error identified later are two fundamental concepts.

   1. Recognition of central tendencies of observed phenomena (central concept of a class).

   2. Recognition or establishment of acceptable limits (boundaries of a class).

   What constitutes a clustering and where is the boundary of such clustering? Some properties do not cluster in a spatial sense, yet we set limits (for example, Soil Taxonomy). Other features may have consistently recognizable boundaries (some slope breaks) with minimal clustering of other properties on either side of the boundary. The question resolves to "how well do we know where and under what conditions the various combinations occur in identifiable landscapes?"

   How well is a probability statement with confidence limits (whether quantified or only implied) that expresses the degree of correspondence (relationships between or among sets of observations. Within a delineated segment of landscape, there is a composition of components which are thought to interact producing an expected behavior when used in a specified way for a particular use.

2. Sources of Error:

   Seven areas that may be sources of error include: the model of soil based on geographical distribution of soil-forming factors; relationships of soil properties to landscapes; applications of Soil Taxonomy; type and scale of field sheets; philosophy of what to emphasize; mapping procedures; and preparation of published maps.

3. Magnitude of Errors:

   It is not easy to assess the magnitude of errors because what happens on the map may result from different deficiences, yet the net or end result is considered to be incorrect. It is one thing to pass judgment on the scientific integrity of a soil survey map, and another to assess the interpretation statements or implications because the standards may differ for different uses by different users. An error can be considered to be incorrect. This implies that something else is correct and we consequently have at least two classes--one correct, and all others that are not correct, but may differ in their degress of departure from correctness. Most evaluation of correctness for class placement is directed to the limits or boundaries of classes rather than in the central concept of the class.

In Table 2 an attempt has been made to scale the sources of error and co give an overall rating by an "X". IL is anticipated thut low sources of error would foster high map accuracies and vice versa.

4. Conclusions:

Mapping procedures is considered to be the biggest source of errors that contribute to lowered accuracy of soil maps. Developing hypotheses of landscape-soil relationships is thought to hove a moderate degree of error and, in part, is reflected by the problems associated with mapping.

The remaining five areas are believed to have low degrees of error and, therefore assist in providing maps of high quality. These areas ore: model of soil, application of soil taxonomy, philosophy of cmphusis, field sheets, and preparation of published maps.

B. Definition and Composition of Map Units

1. Introduction: Five areas that may be sources of error in the definition and composition of map units have been defined. Some refer to our conceptual perceptions of soils and others refer to operational procedures of obtaining and interpreting information.

The five areas of concern are:
- concepts of taxonomic units and mpping units
- working models of soil property-landscape relationships
- population characteristics of map units
- component composit ion of map uni ts
- interpretations of map units

Problems may occur both in the scientific approach as well as in user understanding of the information presented to them.

2. Souces of Error:

a. Unit concepts - too often the difference between taxonomic and cartographic units is misunderstood by soil scientists and uses of soil survey information. The primary purpose of taxonomic units is to provide identity and a mental

Table 2. Relative Sources of Error on Soil Survey Procedures

	Estimated Degree of Error		
	Low	Medium	High
1. Model of Soil	X		
Division of soil-forming factors			
Climate		✓	
Biota	✓		
Parent material	✓		
Topography	✓		
Age	✓		
2. Developing Hypotheses		X	
Refinement of landscape features		✓	
Nature of soil properties			✓
Limits of soil properties		✓	
Understanding factor interactions	✓		
Acceptable correlations of soils and landscapes		✓	
3. Application of Soil Taxonomy in U.S.	X		
Objectives of scheme	✓		
Emphasis on soil process related features	✓		
Mismatch of features needed for use and mgt.		✓	
Constraints of fixed class limits		✓	
4. Map Scale and Type of Field Sheet	X		
Scale	✓		
Ground reference points	✓		
5. Philosophy of Emphasis	X		
User desires	✓		
Tradition in an area		✓	
Using prior series concepts		✓	
Anticipated land use	✓		
Exaggerating high contrast areas		✓	
Maintain scientific integrity	✓		
6. Mapping Procedures			X
Understanding predictability of soil pattern			✓
Mapping skills		✓	
Air-photo interpretation	✓		
Traverse design		✓	
Feature recognition			✓
Generalizing observations			✓
Adherence to quality standards		✓	
Continuing motivation		✓	
Adequate examination of pedons		✓	
Quality control by Party Leader		✓	
Soil correlation--quality and nature			✓
7. Preparation of Published Soil Survey Map	X		
Quality of base maps	✓		
Scale changes	✓		
Correlation changes		✓	
Map compilation	✓		

construct of the mutually exclusive taxonomic classes. Map units consist of the collection of delineated soil areas on a mnp nnd usually Include more variability than permitted by taxonomic classes. Correlation is the process of bringing together the taxonomic naming of classes and the realities of soils which exist or are presumed to exist in delineated areas. Guidelines and procedures for the correlation process are numerous, sometimes difficult to interpret and often not understood by either laymen or professionals.

b. Working Models (Hypotheses) of Soil Property - Landscape Relationships

Legend design is not an easy task because it attempts to combine inprecise correlations of soil properties associated with delineated landscape segments with imprecise correlat ions of behavior expected by users of interpretive information, Most of our efforts have been geared toward understanding the relationships of properties observed in the field to areas that are delineated on maps. How does one design a legend?

Another question concerns testing of relationships, Empherical correlations of observed soil properties with external landscape features is the usual way to develop soil-landscape hypothesis. What about nearly level featureless areas where subsoil nnd substrum propertles rely primarily on sedimentary structures (i.e. floodplains, terraces, lokc bottoms)? A knowledge of geomorphic processes and landforms will likely influence how we test the relationshps and evelop a data base.

c. Characteristics of Map Unit Populations

Very 1 i ttle work has been done on the geography of map units and measures to describe them. A population of delineated units named the same constitute a mnp unit. It has 3 number of delineations varying in size and shape with differing nature of contrast of boundaries with adjacent units and has both an overall pattern as well as a local pattern of occurrence and an assumed internal composition of included components.

Lack of infomration about population parameters or characteristics of map units has largely been overcome by making simplifying assumptions. It would be bettor to obtain information and learn how to describe, define, and even propose criteria for classifying the diversity that seems to exist.

The compelling reason for obtaining information about a map unit is to guide us in designing sampling schemes that will adequately and efficiently permit us to make statement about what can be expected, both in composition and behavior for the map units used in a given survey.

d. Component Composition of Map Units

Over the past ten years data has been accumulating which indicates the complex nature of taxonomic components of map units. Such information eventually is used to adjust or modify guidelines for naming and describing map units.

In most studies of mapping unit composition, the short-range variability from observation to observation within a delineation contributes much more variance than among delineation differences. This suggests that the greatest effort per expended input could be gained by increasing the number of observations within a single delineation rather than increasing the number of delineations observed for the mapping uit. Short-range variability is often the greatest source of error.

Information to be recorded on map unit composition should include : taxonomic classes of pcdons observed, individual soil properties or features, landscape micro-features, vegetation, tonal patterns on airphoto, and so on. Of ten phase components are of equal importance such as slope, stoniness, rockness, erosion, deposition. etc.

e. Map Unit Interpretive Statements

In the past, most attention has been focused on taxonomic composition of mapping units and this aspect is becoming better appreciated. Less emphasis has been placed on interpretive aspects of unit. Most soil information hns been obtained from pedon samples, and interpretations based on these pedons are extrapolated to the map unit named for these classes (Form 5 data and their modifers). This approach has been widely used and accepted, but seldom have there been attempts to qualify our statements with back-up data. This indicates the high reliance we place on the observational skills of field men.

Increased attention has been given to various statistical procedures for expressing the properties observed. These include random schemes for estimating both central tendencies and the amount of variability or ranges about the mean. Less attention has been given to expressing the information as probability statements. Consequently, the lack of guidelines for characterizing the mapping units may permit divergent opinions and results that can be interpreted as errors by some people. Here is a major area that needs to be addressed by the committee. Should confidence statements about mapping "nits be in a narrative form or in tables? How can such statements on tables be drafted so they are readily understood by the layman?

3. Magnitude of Errors

The estimated degrees of error result from a lack of available information and how to express the results in a meaningful way. Wc appear to be at a threshold of grasping the problem nnd developing approahces to obtain quantifiable Information. Often it does not have to be rigorous or tedious, rather it can be based on taking advantage of the keen observational skills of people who work in the field. However, those observations must be recorded and where obvious discrepancies occur, then testing should be undertaken.

	Estimated degree of error		
	Low	Medium	Hi &
Concept of units	x		
Working models	x		
Population characteristics		x	
Component composit ion			x
Unit interpretations			x

VIII'. RECOMMENDATIONS

A. Long-Range

1. A subcommittee bc established to develop alternative procedures (detailed format and statistical designs) to assess:

   a. the taxonomic composition ot soil map units

   b. the variability of pertinent soil properties comprising map unit components;

   c. the confidence limits relative to above attributes; and

   c. soil performance interpretations.

The assessment should be commensurate with the scale of mapping and objectives of the survey (i.e. the major response unit and major land uses of the survey).

2. To encourage Regional Committees and cooperators of the NCSS program continued development and testing of alternative approaches that permit greater quantification of soil survey information and procedures (i.e.. design of mapping units. developing soil-landscape models, predicting soil patterns, enhancing mapping skills, developing taxonomic concepts, etc.).

3. To program for a redirection of NCSS emphasis and efforts towards greater quantification of mapping unit composition as interlinked with soil performance interpretations.

B. Short-Range

1. Develop model drafts of confidence statements that could bc utilized to transfer information gained in items 1(a) thru 1(d) to map unit definitions in the soil survey report.

2. Develop additional narrative material that could be incorporated into the Introduction Section of the soil survey report to set forth more clearly:

   a. objectives of the soil survey

   b. the manner in which the soil survey is made so the user may better appreciate its applicability and limitations (i.e. number of observations, location of observations relative to the landscape, laboratory verification development of soil-landscape models, etc.)

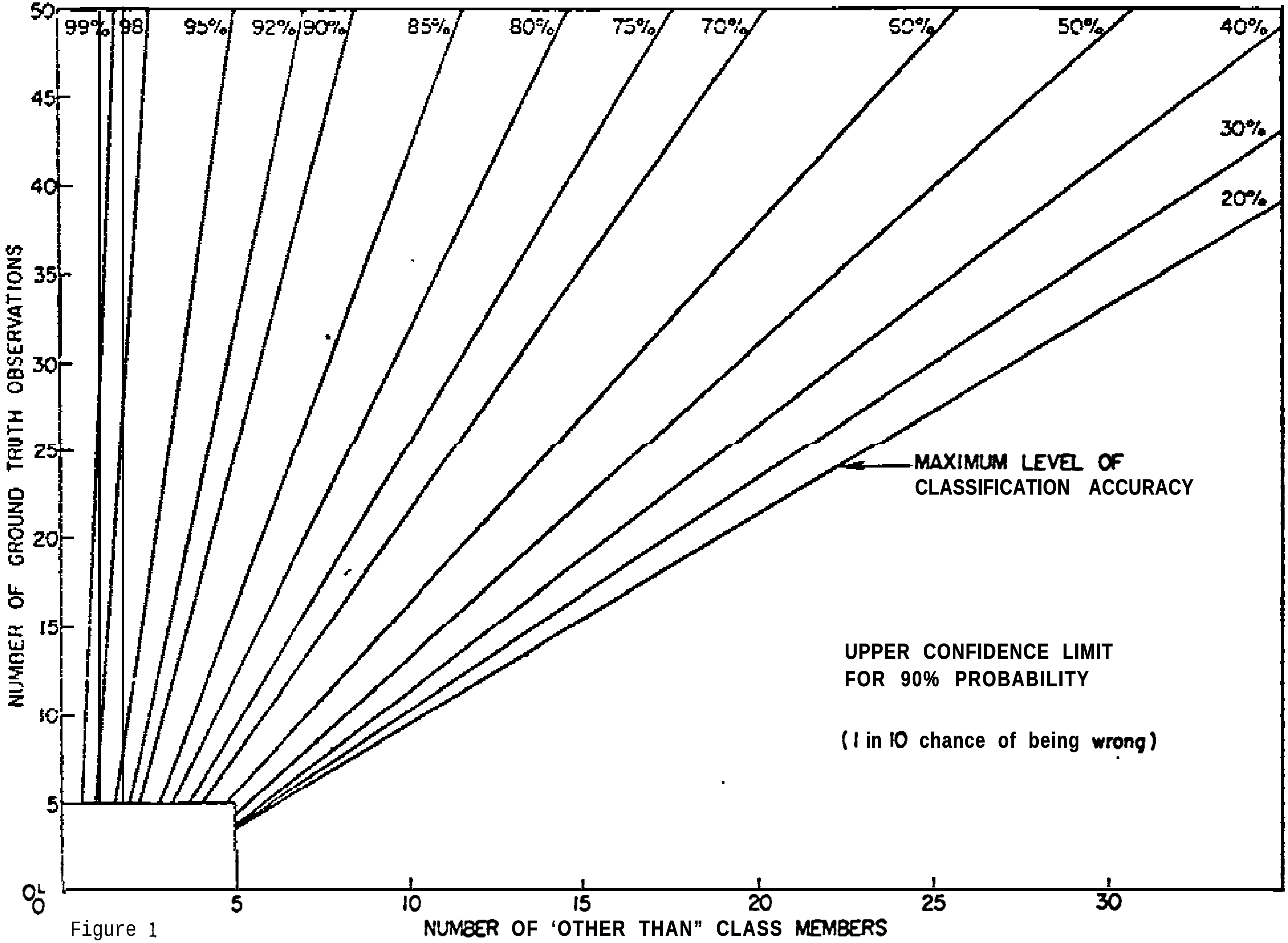
   c. provide the user with a generalized understanding of the relative magnitudes of soil property variability that could be expected in a landscape unit (i.e. increasing variability with scale factor from a pedon to the landscape as whole, chcmicnl properties, solum thickness, hydraulic conductivity generally more variable than physical properties such as particle-size, surface horizon thickness, soil pH, color, etc.).

3. Develop more not less comprehensive descriptions of mapping units including kinds, amounts and spatial distribution of component soils. Incorporate specific probability statements of confidence limits of soil composition when data is available. Illustrate schematically spatial relationships of soils or specific properties pertinent to soil performance. Include more definitive information on surface horizon thickness.

4. Develop a section in the manuscript regarding generalized aspects of soil water movement in a vertical and lateral vector. Consider infiltration. permeability, topography. restrictive layers, etc. Develop for the layman, model concepts of water movement from upslope to downslope landscape components. Relate water changes to possible impact on soil behavior (i.e. water supplying capacity, seasonal watertables, trafficability. soil strength and stability, corrosivity, etc.)

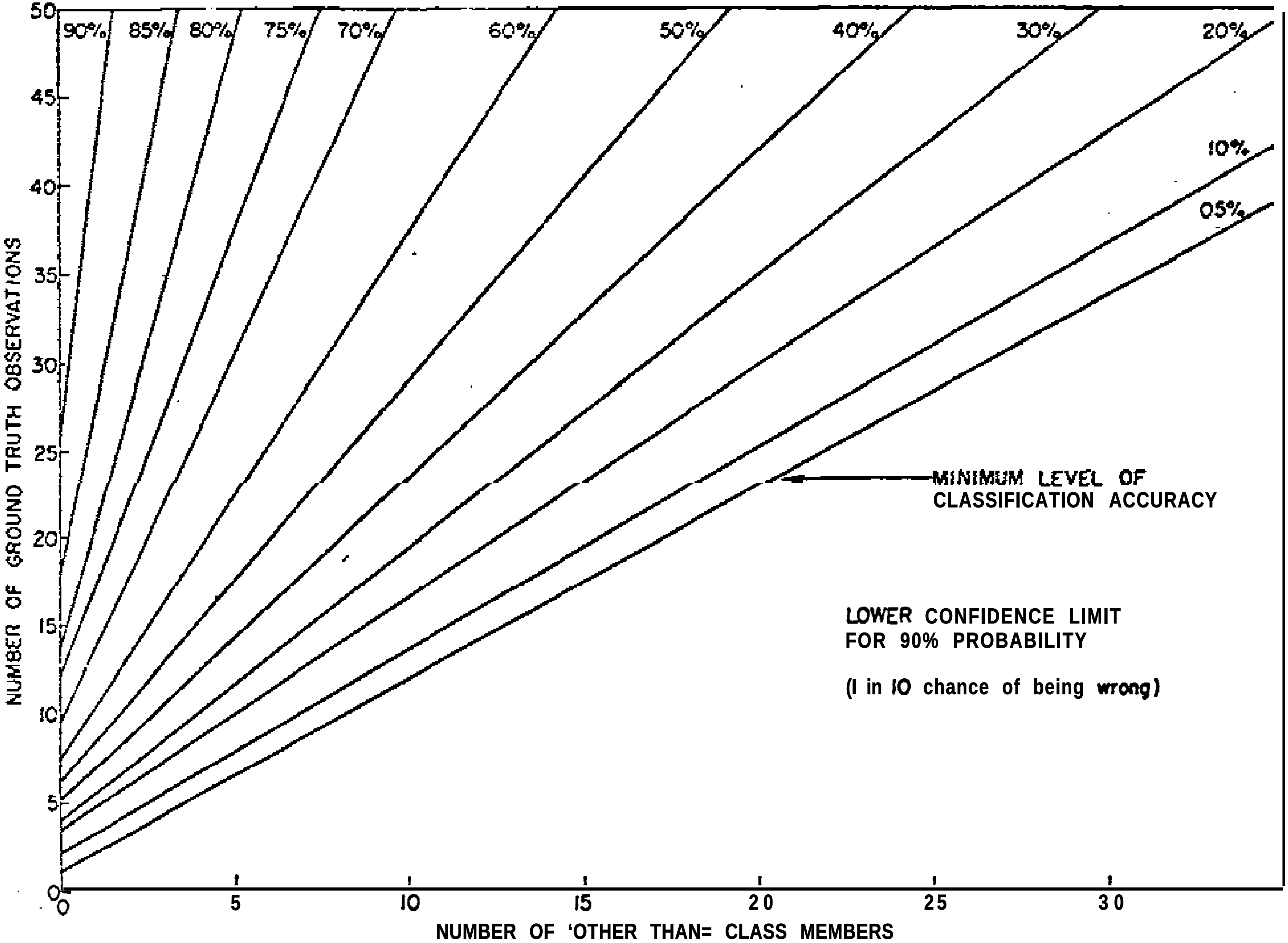
5. Develop more detailed narrative with appropriate schematics (block diagrams), the soil-geology-hydrology relationships. Relate such data to water movement, stability, construction liabilities, pollution potential, etc. This provides a means to interface soil-geology inferences.

6. Coordinate cooperative planning efforts to obtain crop yield and climatic data by major soils two or three years before survey is to he initiated so five to six years of information would be available at time survey is ready for publication. Greater efforts should be made to bring in stntc and county extension efforts and personnel from Economic Statistics and Cooperative Service



99%
98
95%
92%
90%
85%
80%
75%
70%
60%
50%
40%
30%
20%
MAXIMUM LEVEL OF
CLASSIFICATION ACCURACY
UPPER CONFIDENCE LIMIT
FOR 90% PROBABILITY
(1 in 10 chance of being wrong)
NUMBER OF GROUND TRUTH OBSERVATIONS
NUMBER OF 'OTHER THAN" CLASS MEMBERS
0
5
10
15
20
25
30
35
40
45
50

Figure 1



90%
85%
80%
75%
70%
60%
50%
40%
30%
20%
10%
05%
MINIMUM LEVEL OF CLASSIFICATION ACCURACY
LOWER CONFIDENCE LIMIT FOR 90% PROBABILITY
(I in IO chance of being wrong)
NUMBER OF GROUND TRUTH OBSERVATIONS
0
5
10
15
20
25
30
35
40
45
50
NUMBER OF 'OTHER THAN= CLASS MEMBERS

Figure 2

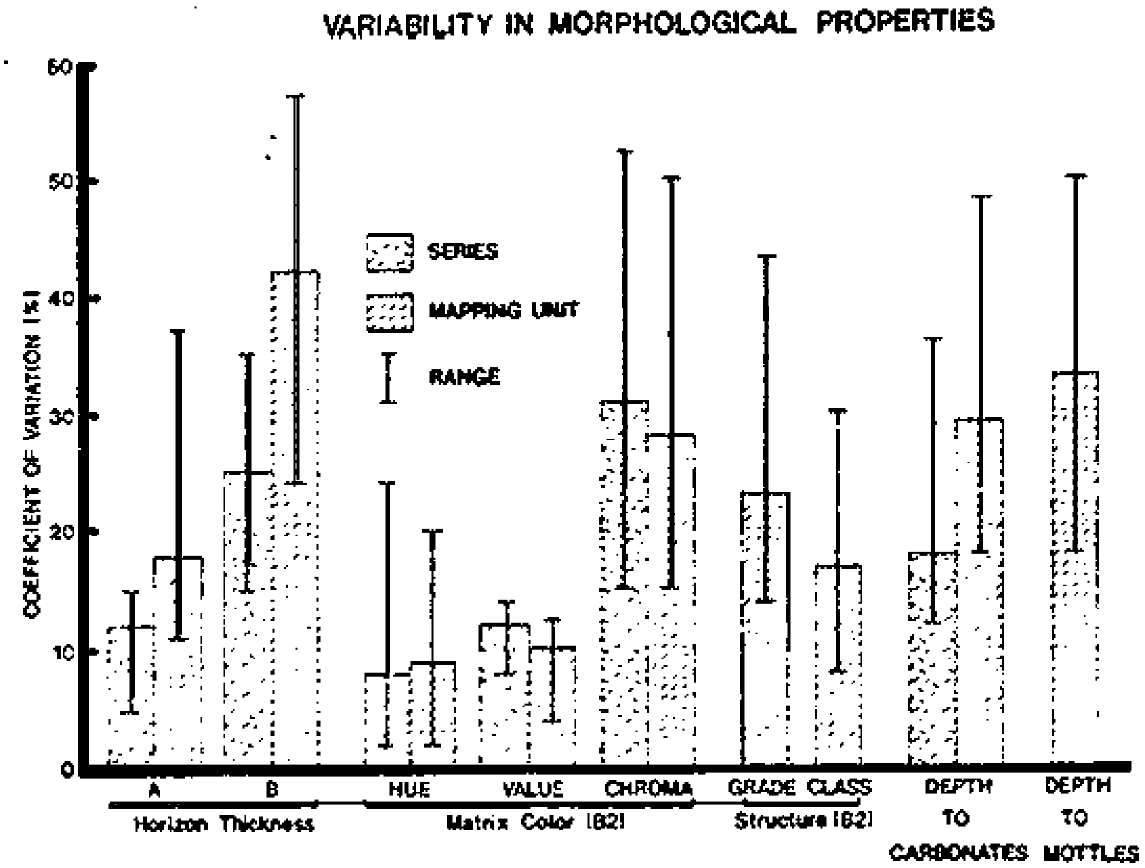


Figure 3. Observed variability among selected morphological properties as a function of landscape units (mapping unit delineations), and respective series concepts.

(L. P. Wilding and L. R. Drees. 1978. Spatial Variability - A Pedologist's Viewpoint. SSSA Special Publication [Diversity of Soils in the Tropics]. Chpt. 1:1-12).

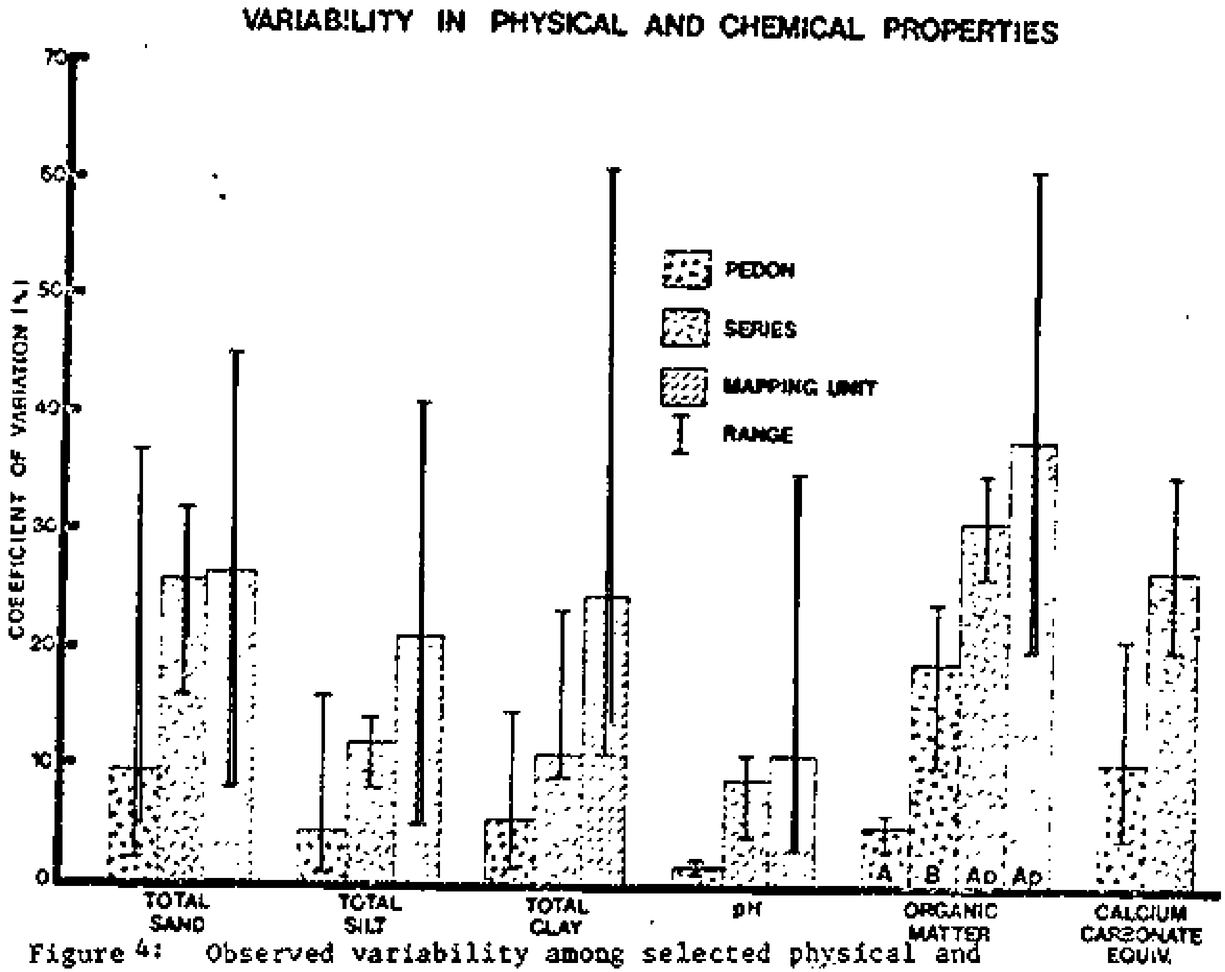


Figure 4: Observed variability among selected physical and chemical properties as a function of pedons, landscape units (mapping unit delineations) and respective series concepts.

(L. P. Wilding and L. R. Drees. 1978. Spatial Variability - A Pedologist's Viewpoint. SSSA Special Publication (Diversity of Soils in the Tropics). Chpt. 1:1-12).

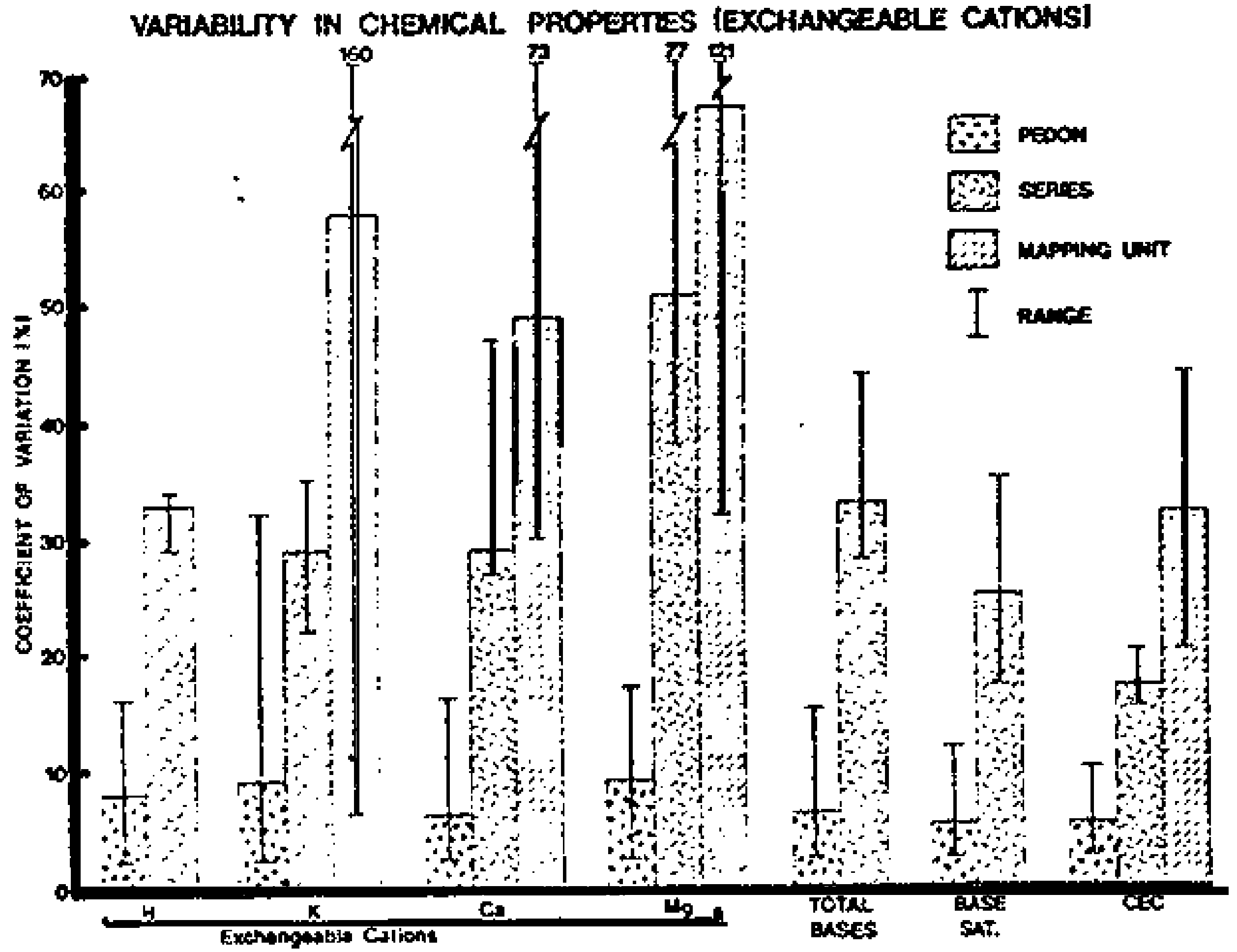


Figure 5. Observed variability among selected cation exchange properties as a function of pedons, landscape units (mapping unit delineations) and respective series concepts.

(L. P. Wilding and L. R. Drees, 1978. Spatial Variability - A Pedologist's Viewpoint. SSSA Special Publication [Diversity of Soils in the Tropics]. Chpt. 1:1-12).

COEFFICIENT OF VARIABILITY VERSUS NUMBER OF OBSERVATIONS NECESSARY TO ESTIMATE POPULATION MEAN WITHIN SPECIFIED LIMITS

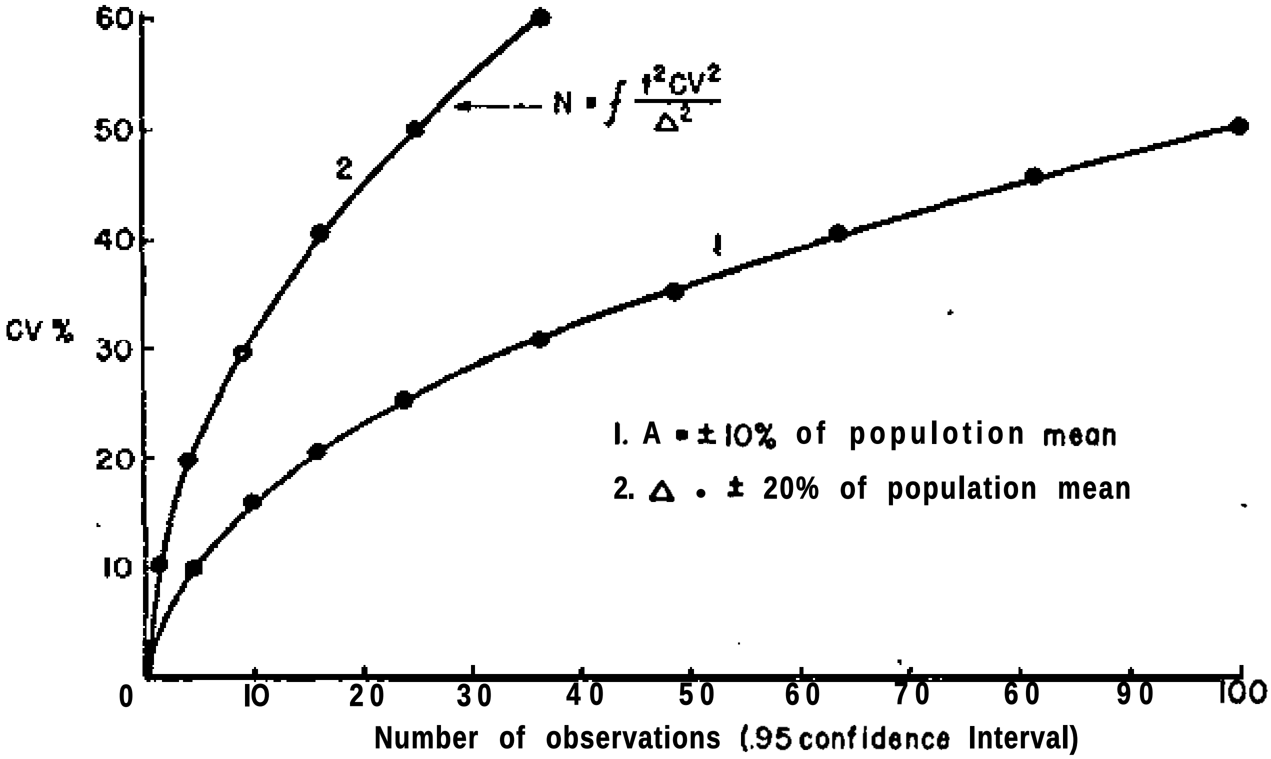


Figure 6 – I.. P. Wilding. 1972. Developing concepts and diagnostic Criteria for soil classification. Proc. of a Symposium on Classification of Soils and Sedimentary Rocks. Guelph, Ontario.

NATIONAL WORK PLANNING CONFERENCE
OF THE
COOPERATIVE SOIL SURVEY

San Antonio, Texas
January 29-February 2, 1979

Committee 6
Soil-Water Relations

Richard A. Dierking
G. W. Olson
Walter Russel
Richard W. Kover
Earl R. Blakley
A. R. Southard
Robert W. Johnson
Thomas W. Priest
Sidney A. Pilgrim
Kenneth C. Hinkley
George E. Otte

E. J. Ciolkosz
J. B. Fehrenbacher
William R. Wright
Thomas E. Calhoun
Ronald F. Paetzold
B. A. Touchet
Charles McBee
Luis H. Rivera
Arthur D. Kuhl
Bruce G. Watson

Maurice Stout, Jr., Chairman
John E. McClelland, Advisor

SOIL-WATER RELATIONS

Most soil-water relations are dynamic phenomena. Because of the forces of gravity, matric tension, evaporation, and transpiration, the soil water conditions are constantly changing. They may change in a few hours or days or over a season or a year or longer. They may be changing at such a slow rate that they appear to be permanent.

When describing a soil, the soil-water state and the date are recorded in order to relate to the soil properties at that time. Ideally, the soil-water state would be observed for each soil at least once a month during the year. However, the soil scientist can generally make observations only during the time the landscape is traversed; hence, patterns of soil-water states will have to be estimated by using available climatic data and evaluating the position of the individual soils in the landscape.

[This introductory material may be omitted depending upon the manner in which the material on soil water and related topics are placed in the text. Conflicting recommendations were offered and it may be besl to omit.]

Soil-Water States

Soil-water state is the term used for a defined moisture condition. Three soil-water states--dry, moist, and wet--can be estimated in the field.

The soil-water state should be recorded when a pedon or other sample unit is described. Differences in the soil-water state cause variation in color, consistence, and grade of structure of soils. In addition, accumulated observations over a length of time can establish the pattern of soil-water states. By comparing field observations with data on precipitation and evapotranspiration, a complete sequence can be determined. Color also is indicative of degrees of moisture content with grayish colors and mottles in zones of longest concentration and bright colors in zones of no or short concent-at ion. Boreholes are more precise indicators of the persistence of the wet state.

A soil or soil horizon is considered to be dry when the water is held at a tension of 1,500 kPa (15 bars) or more. The soil-water content in the dry state is less than that required to keep most mesophytic plants alive. The term air-dry means that the soil is in equilibrium with the air. The amount of water in the soil will vary with the humidity, but an air-dry state can be attained in the field or office by letting the soil dry in the air. When a soil is air-dry, the water is held at tension much greater than 1,500 kPa (15 bars).

A soil or soil horizon is considered to be moist when the water is held at tension between 1 kPa (10 cm H_2O or 0.01 bar) and 1,500 kPa (15 bars). This represents the range from just above the water content at which most mesophytic plants wilt beyond recovery in a humid atmosphere (wilting point) to an arbitrary point. The amount of water in the soil and the soil properties change appreciably within the moist state. Consequently, for some purposes it may be useful to separate the drier half of the moist class from the wetter half as slightly moist and very moist, respectively, and separated at 1/3 bar (or .1).

Soil is considered to be wet when it contains free water. Free water is water that is at a tension of 0 kPa (0 bar) or less. Depth to free water is defined as the depth to water standing in a freshly dug uncased borehole after adequate time has elapsed (about 1 day) for the adjustments in the surrounding soil.[1/] The lower boundary of a zone of free water is established through emplacement of two or more cased boreholes at different depths. In practice, the depth to and thickness of zones of free water are estimated during mapping, and boreholes are generally not used.

Thickness and continuity of the zones of free water vary greatly. The free water may be restricted to a single thin zone near the soil surface. In soils having a fragipan, free water often occurs above the fragipan but not below. Two or more layers of free water may be separated by less saturated soil material. This often happens in soils that formed in stratified alluvium that is mostly clayey but contains loamy and sandy bands. In many soils, free water is continuous from its highest level to the depth normally observed during a soil survey.

Several kinds of field clues can be used to determine soil-water state. In wet soil, water films on the surfaces of sand grains and peds are visible without magnification. Excavation through a wet horizon will cause water to

---

1/ Water may be under pressure and rise in the borehole above the level of free water (artesian pressure). In these cases, depth to water in the borehole is less than the depth to free water.

flow down the exposed face, though flow may be very slow and confined to large pores and cracks. Many clayey and loamy horizons of high hulk density contain very few pores that drain under 1 kPa (0.01 bar) auction.

Most soils become perceptibly darker on moistening within the range of slightly moist. The change of color within the range of very moist is nearly always leas and is negligible for some soils. A hall of moist soil materials can be formed in the hand by firm pressure at moisture states of very moist or wet for soil textures finer than fine sand or loamy fine sand. A hall may be formed at progressively lower moisture content as silt increases relative to sand and as clay increases. Many clayey soil materials, especially those high in 2:1 lattice clays, may be formed into balls when they are slightly moist. If, after thoroughly destroying the soil structure, a "thread" 3 mm in diameter can he formed by rolling the soil. between the palms of the two hands and the thread does not crumble when handled, the material is moist or wet..

Soils are considered flooded when they are inundated by moving water originating from stream overflow, runoff, or tides. They are considered ponded when Lhry are covered by water from adjacent slopes. Ponded soils are generally in closed depressions.

Water Movement

The amount nnd rate of water moving over, into, and through the soil are controlled by supply, by internal and external, soil properties, and by environmental factors. Soil properties influencing water movement include slope, surface roughness, water repellency, cracking, coarse fragments, structure, total porosity, pore-size distribution, and water content. Environmental factors include form of precipitation, vegetative cover and spacing, and temperature. Any factor increasing the resistance to flow decreases the rate and amount of water moving over, into, or through the soil. For example, surface roughness increases resistance to flow of water over the soil, while increasing slope decreases resistance. Water repellency increases the resistance lo flow into soil. Since water moves much more easily through large pores than small ones, the pore-size distribution of a soil largely determines its internal resistance Lo water flow. Cracking, structure, coarse fragments, and porosity determine the cross-sectional area available for water movement through soil. Decreasing Lhe cross-sectional area available for flow decreases the rate and amount of water movement through the soil Decreasing the soil-water content decreases the cross-sectional area available for water flow, since water moves in the liquid phase. In other words, air arts: like coarse fragments and decreases the area available for flow. Environmental factors influence water movement. mainly by controlling the amount, rate, and distribution of water reaching the soil surface.

The term runoff is used to describe the movement of water across the surface of the soil. Infiltration is the entry of water into the soil at ils surface. Percolation is the movement of water from an uncased borehole into surrounding wet soil Hydraulic conductivity is a proportionality term relating soil-water flux to hydraulic gradient. Saturated hydraulic conductivity is the term used if the soil is saturated and unsaturated hydraulic conductivity if the water is under tension; hoth terms for hydraulic conductivity can be applied to vertical or horizontal water movement. Permeability classes are based on saturated hydraulic conductivity.

Runoff is the principal term used to describe external water movement, and permeability is the principal term used to describe internal water movement in the soil.

Runoff

Runoff is the term referring to the portion of precipitation lost by flow over the soil surface and to the periods when excess water stands on the soil surface.[2/] Surface water includes water falling as rain or water flowing onto the soil from other surfaces. Six classes of rate of runoff may be recognized. The relative rate and loss from the soil surface is determined by the internal and external characteristics of the soil and by the climate and vegetative cover.

Runoff can also vary significantly on soils under natural cover, under cultivation, and under different kinds of management. Many soils that have slow or medium runoff under natural conditions may have rapid or very rapid runoff when cultivated. These conditions must be taken into consideration when evaluating runoff.

Classes for rate and amount of runoff are applied to mapping units. The interrelationship of soils and phases is recognized. Phases such as stony and eroded soils are evaluated for runoff.

Ponded

Little of the water added to the soil as precipitation or by flow from surrounding higher land escapes as runoff. The total amount of water that must be removed from ponded areas by movement through the soil or by evaporation is usually greater than the total rainfall. Ponding normally occurs on level to nearly level depressions1 soils, and the depth of water may fluctuate greatly seasonally.

Very Slow

Surface water flows away so slowly that free water stands on the surface for long periods. Soils are commonly level or nearly level. Most of the water either passes through the soil or evaporates, but some soils absorb precipitation so rapidly that little or no water can run off.

Slow

Surface water flows away slowly enough that free water stands on the surface for intermediate periods. The soils are either nearly level or very gently sloping. Most of the water passes through the soil or evaporates, but some soils absorb precipitation rapidly enough that only a little water can run off.

Medium

Surface water flows away fast enough that free water stands on the surface for only short periods. Soils with a medium rate of runoff are either nearly level to gently sloping with moderate absorption of precipitation or have steeper slopes and high rates of ahsorption. A part of the precipitation is absorbed by the soil and used for plant growth, is lost by evaporation, or moves downward into underground channels.

2/ Runoff is defined as "that part of precipitation appearing in the surface streams" (Gary, et al., 1972). Besides surface runoff there is <u>subsurface flow</u> or interflow that results when infiltrated water enters a zone with a higher perviousness than the soil below. Water accumulates in this zone and moves laterally. There is also <u>base flow</u> which comes from material storage such as swamps, aquifers, and from water in temporary storage in adjacent alluvium.

Rapid

Surface water flows away fast enough that the period of concentration is brief and free water does not stand on the surface. Soils with rapid runoff are mainly moderately steep to steep with moderate to low rates of absorption. The soil absorbs only a small part of the water.

Very Rapid

Surface water flows sway so fast that the period of concentration is very brief and free water does not stand on the surface. Soils with very rapid runoff are mainly steep or very steep with a wide range of rates of absorption of precipitation. The soil absorbs only a very small part of the water.

Permeability

Permeability is the capacity of soil to transmit fluids (water). Permeability classes are defined in terms of saturated hydraulic conductivity. Field estimates of permeability are based on correlations that have been made between field morphology and laboratory determinations of saturated hydraulic conductivity on a few soil cores.

Permeability of either the soil as a whole or of a particular horizon can be given. The horizon with the lowest value determines the class of the whole soil. If an appreciable thickness of soil below the least permeable horizon is significantly more permeable, then both permeablities may be given.

Permeability does not describe the capacity of soils in their natural setting to dispose of water internally. A soil may have high permeability throughout yet contain free water at shallow depths because there are impermeable or more slowly permeable underlying layers that restrict movement or because the soil is in a depression where water from surrounding areas accumulates at a faster rate than it can pass through the soil. The water may actually move very slowly despite the high permeability. Further, permeability does not describe Che capacity for water movement under unsaturated conditions. The unsaturated hydraulic conductivity is more significant for most soil uses, particularly those related to plant growth, than is permeability. A sufficient base of data and experience does not exist for construction of classes. Unsaturated hydraulic conductivity at very low tensions (up to .01 bar) is closely related to permeability for many kinds of horizons Because of this close relationship, permeability is useful for predicting behavior when soil contains water at tensions between O and 1kPa (0 and 0.01 bar).

For most soils, no direct measurements of permeability have been made. Rates of movement often must be inferred from soil morphology and behavior or projected from measurements made on similar soils.

The high roles of permeability occur in soils or horizons composed largely of gravel, sand, or both, with little silt and clay and with large connected voids. The low rates of permeability occur in structureless soils or in soil horizons with fine and discontinuous pores (as in some clays, fragipans, or cemented horizons). Medium rates of moisture movement, occur in soils or soil horizons that transmit water rapidly enough to remain wet for only a moderate time after thorough wetting.

Soil of low permeability has so low a capacity to transmit water vertically that it remains wet for periods of a week or more after thorough wetting. Plant roots are usually few or absent and are localized along cracks Lhat close completely when the soil is wet. Horizons may be massive, blocky, or platy. There are few connecting pores that could conduct water when the soil is wet. If the soil cracks when dry, the cracks close completely on wetting. Structural plates or blocks arc commonly overlapping. Slickenaides and continuous stress surfaces are indicative.

Soil of medium permeability has enough capacity to transmit water vertically that the horizon or the soil remains wet for no more than a few days after thorough wetting. The soil material holds large amounts of water against the force of gravity. Horizons may be massive, granular, blocky, prismatic, or weakly platy if they contain common continuous pores. If the soil cracks when dry, the cracks may not close on wetting. The class includes many soils considered physically favorable for rooting and for supplying water for plants.

Soil of **high** permeability has enough capacity to transmit water vertically that the horizon or soil remains wet for no more than a few hour6 after thorough wetting. Horizons and soils have many continuous conducting pores (usually medium to coarse). If the soil cracks when dry, the cracks may not close on welting. Some medium- and fine-textured horizons have strong granular structure and large connecting pores. Others have many large voids, pores, or root channels that transmit water rapidly. Some artificially drained marine clays have large cracks through which water moves rapidly. Horizons that are largely volcanic cinders commonly have high permeability. The size and continuity of pores and voids are the critical factors. Many pores and voids are large enough to be distinguished easily; their continuity and persistence when soils are wet must be determined as well. The high permeability class may be subdivided into rapid and **very** rapid. **Very** rapid **permeability** distinguishes those soil bodies dominated by coarse fragments of rock without enough fines to fill the voids between them, soils with large permanent cracks, some soils with many worm holes, and some that are coarse sand, very coarse sand, or gravelly sand.

Permeability	Saturated Hydraulic Conductivity		
	cm/day	m/s	in/hr
High			
very rapid	>1200	$>1.39 \times 10^{-4}$	>19.7
rapid	400-1200	4.63×10-5-1.39×10^{-4}	6.56 - 19.7
Medium			
moderately rapid	100-400	$1.16 \times 10^{-5}-4.63 \times 10^{-5}$	1.64 - 6.56
moderate	40-100	$4.63 \times 10^{-6}-1.16 \times 10^{-5}$	0.656 - 1.64
moderately slow	10-40	$1.16 \times 10^{-6}-4.63 \times 10^{-6}$	0.164 - 0.656
Low3/			
slow	4-10	$4.63 \times 10^{-7}-1.16 \times 10^{-6}$	$6.56 \times 10^{-2}-0.164$
very slow	0.4-4	$4.63 \times 10^{-8}-4.63 \times 10^{-7}$	$6.56 \times 10^{-3}-6.56 \times 10^{-2}$
extremely slow	<0.4	$<4.63 \times 10^{-8}$	$<6.56 \times 10^{-3}$

$m/s = cm/day \times 1.157 \times 10^{-7}$
$in/hr = cm/day \times 1.640 \times 10^{-2}$

3/ The upper limit of the lov class exceeds by 10- to 100-fold the maximum permeability permitted for many kinds of reservoirs. Furthermore, some soil materials below the zone of soil development, where vertical planes of weakness have not developed, have permeabilities lo-fold or more **below the upper limit of the low class. It is, therefore, desirable to make subdivisions of the low class.**

Soil Wetness Classification

Soil wetness is characterized bv the depth to. duration and thickness of. and the time of the year during which the wetness state occurs. Soil wetness. is constantly changing but can be used to record conditions in the soil at the moment of observation or to characterize the moisture regime of the soil. See table 4-3, Annual Soil-Water Regime. For example, an observation may have a notation, "dry to 1 meter," or "free water at 1 meter, moist above." A soil moisture regime may be characterized as "wet one-fourth to one-half of the time between 25 cm and 50 cm; wetness occurs during March through June and in October; zone of wetness extends to fragipan at 36 inches." Soil wetness classes express soil wetness more precisely than soil drainage classes which are overall appraisals of the wetness states of a soil in respect to runoff, permeability, slope, climate, and other variables considered. Soil wetness classes relate to but are not directly convertible to soil drainage classes. Soil drainage classes are often inferred from the morphological record in the soil caused by soil moisture or lack of soil moisture.

Soil wetness is best used when data are available throughout the year to show the seasonal fluctuations of zones of wetness. Data obtained over longer periods better characterize the soil moisture and provide for a stable base on which to develop statements concerning the use of the soil. The soil wetness may be determined at the time of a single observation, hut generally these evaluations are made only to note presence or absence of free water. Morphological records are not used in this classification because of the variability of the soil-water states. The successful use of soil wetness classes depends on adequate data taken over a sufficiently long period. Therefore, some system of gathering data needs to be established. Therefore, it is essential that free water be present or some system of gathering data on soil wetness be used.

Certainly, reliable soil wetness information is more desirable and useful than classes of soil drainage. It enables one to better understand the soil-water relations and, because of this, make better recommendations concerning the soil's use.

Depth to the wet state 4/

1. Never wet above a depth of 1.5 m for longer than a few days at a time. 5/

2. Wet in some part above a depth of 1.5 m but. not above a depth of 1 m for longer than a few consecutive days at a time.

3. Wet in some part above a depth of 1 m but not above a depth of 50 cm for longer than a few consecutive days at a time.

4. Wet in some part above a depth of 50 cm but not above a depth of 25 cm for longer than a few consecutive days at a time.

5. Wet above a depth of 25 cm for longer than a few consecutive days at a time.

4/ Based on soils that are not irrigated and not frozen in any part.

5/ A few days may be required for water to drain out of a soil after a period of high precipitation or temporary flooding. The period may vary from a few hours to usually less than 3 days.

Duration of the wet state [6/]

A. Wet leas than 1/12 of the time.
B. Wet 1/12 to 1/4 of the time.
C. Wet 1/4 to 1/2 of the time.
D. Wet 1/2 or more of the time.

Periods of persistence

The period of time during the year wetness occurs is of importance. Agriculturally, soils which are wet during periods outside of the growing season have a potential that is more favorable than one wet during planting or growing season. A soil that is wet leas than one-twelfth of the time may not have much value for cultivated crop if the wetness is during the critical planting or harvesting period. Duration periods of wetness and depth Lo wetness are shown graphically in table 4-3, Annual Soil-Water Sequence. The months a soil is wet are shown. Some soils have more than one wet period during the calendar year.

The wetness state is normally defined in describing a soil by stating the depth Lo, duration of, and period of wetness. The wetness state can also be symbolized hy using the classes listed.

Example: A soil that is wet above a depth of 100 cm for 110 to 140 days each year, but never longer than 2 or 3 days above a depth of 50 cm, Is in wetness class 3c.

If the wet layer continues to a depth of 150 cm (or to bedrock above a depth of 150 cm), no further symbolization is needed. If the wet layer rests on a restrictive layer, such as a fragipan that is dry or moist, the wet layer is perched. The letter "p" is added to the class symbol, and the average thickness of the wet layer is given: 3cp (15 cm). The moisture state below the pan is also given.

The periods of the year wetness occurs are expressed using 1 for January and sequentially through 12 for December. Wetness from January through March would be 3 cp 1-3; September through December 3 cp 9-12; or twice a year 3 cp 1-3/9-12.

Annual Water-State Regime

The annual water-state regime is a continuous record of the water state. The water state of the soil above bedrock is evaluated for designated layers, specifically the layers used in defining wetness classes. A moisture regime for a hypothetical soil is shown in table 4-3.

[6/] Periods of wetness of a few days are disregarded. Subclasses are used in wetness classes 2, 3, 4, and 5 only.

Table 4-3 Annual Soil-Water Regime

Depth (cm)	J	F	M	A	M	J	J	A	S	O	N	D
0-25	f	f	m	m	m	m	d	d	d	m	m	f
25-SO	f	f	f	w	m	m	m	d	d	d	m	w
50-100	w	w	w	w	m	m	m	d	d	d	m	m
100-150	w	w	w	w	w	m	m	m	d	d	d	m

f - frozen more than half of the month
w - wet more than half of the month
m - moist more than half of the month
d - dry more than half of the month

A more detailed approach can he used. The moist state ran be divided into slightly moist and very moist. The presence of free water in the wet state can be indicated. Free water may not be evident. where there are no noncapillary pores.

Available Water Capacity

The amount of water a soil can hold in a state that plants ca" use and at a place in the soil where plant roots have access to it is appraised by (1) estimating the amount of water each horizon can hold, (2) estimating what horizons or parts of horizons are sufficiently accessible to plant roots to he significant source!; of water, and (3) summing up the available water capacities of the various horizons to the depth plant roots can be reached. The sum is called the available water capacity of the soil. It does not reflect the amount of water a soil will supply for plants; that depends on rainfall, runoff, run-o", irrigation, water requirements of plants, and the like.

Available water capacity is the difference between field capacity and the permanent willing percentage. The concept of available water capacity ran apply Lo a horizon or the whole soil.

Many kinds of materials affect available water values, including bedrock, cemented layers, and saturated zones. Generally, in a horizon having a bulk density of 1.8 or more when moist and distances greater than 10 cm between planar voids larger than 0. 1 mm when moist, moisture is not accessible to mosl roots. Horizons of higher bulk density generally lower available water values. Fragmental soils or horizons have reduced values for available water capacity.

Estimates of available water capacity can be made on the basis of field measurements and observations, supplemented by any available laboratory data. Relationships can be established, such as that between field estimated clay content and moisture at 15 bar tension.[7] Such relationships apply only

[7] Percent clay x 15 H_2O x BD = available water capacity.

within a limited range of soils. Nevertheless, standards can be established within regions and applied as useful estimates. When evaluating water supplying capacity of soils, consideration must be given mainly to the volume of rock fragments, osmotic pressure from salts in the soil water, bulk density, kind and amount of clay, structure of the soil, and stratification by horizons of contrasting texture in addition to climatic factors, slope, runoff, and contrasting horizons or soils having abrupt boundaries.

Soil Drainage

Soil drainage refers to the removal of waler from the soil. It is the overall evaluation of the removal of water as influenced by climate, slope, and position in the landscape. The precipitation, runoff, amount of moisture infiltrating the soil, and rate of movement through the soil affect the degree and duration of wetness. Moat soils which have repeated soil wetness in all or part of the profile are mottled and/or have dull colors. Soils that are well drained generally lack the dull colors or the mottled array of bright and dull colors. Soils that are very wet often lack mottles and are uniformly gray throughout. the zone of saturation. Soils having much organic matter may be without visible mottles because the dark organic colors mask the mottles.

Soil drainage classes are used to describe the different degrees of soil wetness. Soil morphology, mostly color, is used lo infer the degrees of wetness, relative duration, and the location of the zone or zones within the profile that are periodically saturated under natural conditions. These relations are further supported by observation of water table depths and fluctuations; data from teat holes; and evaluation of climate in respect to amount, distribution, and intensity of rainfall, runoff, evaporation, and other available information.

Not all wet soils show a record of soil wetness. Some soils are very slowly permeable yet are unmarked because they are rarely wet or are rarely wet long enough lo leave a record in the soil. Others arc wet, but the water contains sufficient oxygen to maintain bright, unmottled soil colors. Sands often have too few fines lo display colors indicating reduction. Some soils have prominent mottles but are not considered wet. Colors, in these instances, may be relics from a wetter period, peculiar to a weathering sequence, or inherited from the geologic deposit and its ancient environment.

Excessively Drained

Water is removed from the soil very rapidly. These soils arc commonly shallow or very porous or steep, or a combination of these conditions. They are free of mottling throughout the profile. (Includes soil wetness classes 1 and 2.)

Somewhat Excessively Drained

Water is removed from the soil rapidly. These soils are very porous or steep or shallow or moderately deep, or some combination of these conditions. They are free of mottling throughout the profile. (Includes soil wetness classes 1 and 2.)

Well Drained

Water is removed from the soil rapidly enough for the soil to be mainly free of mottles and dull colors in the upper 1 meter. (Generally includes soil wetness classes 1 and 2.)

Moderately Well Drained

Water is removed from the soil so slowly that the profile is wet between depths of 50 cm and 100 cm long enough to cause mottled and dull colors. These soils generally have a slowly permeable layer or a relatively high water table or additions of water through seepage or runoff, or some combination of these conditions. (Generally includes soil wetness classes 2a, 2b, 2c, 2d; and 3a, 3b, 3c if wet between 1 m and 1.5 m less than one-half of the time; and 4a, 4b, 5a if wet between 1 m and 1.5 m for no more than one-fourth of the time.)

Somewhat Poorly Drained

Water is removed from the soil so slowly that the profile is wet within a depth of 25 cm to 50 cm long enough to cause mottled and dull soil colors. These soils may have a slowly permeable layer or a high water table or additions of water through seepage or runoff, or some combination of these conditions. (Generally includes wetness classes 3d; and 3a, 3b, 3c if wet between 1 m and 1.5 m more than one-fourth of the time; and 4a, 4b, 4c if wet between 1 and 1.5 m less than one-half of the time; and 5a, 5b if wet between 50 cm and 1 m for more than one-fourth of the time.)

Poorly Drained

Water is removed so slowly that the soil is either saturated periodically during the growing season or it remains wet long enough to cause mottles and dull colors within a depth of 25 cm. These soils generally have a high water table or a slowly permeable layer or additions of water through seepage or runoff, or some combination of these conditions. They are mottled or have dull colors throughout the profile below 25 cm. (Generally includes soil wetness classes 4d; and 5d if free water is not at or near surface more than one-half of the time; and 4a, 4b, 4c if wet between 50 cm and 100 cm more than one-half of the time; and 5a, 5b, 5c if wet between 50 cm and 1 m less than one-half of the time.)

Very Poorly Drained

Water is removed so slowly that free water remains at or on the surface most of thr time. These soils generally have a high water table or a slowly permeable layer or additions of water through seepage or runoff, or some combination of these conditions. Most of them are level or nearly level and have plane, concave, or depressed surfaces that are frequently ponded. Some that are wet from seepage are on sloping upland or are at the foot of a slope. If not dark colored, these soils are mottled or dull colored in and below the surface layer. (Includes soil wetness classes 5d, and free water is at or near the surface more than one-half of the time.)

NATIONAL COOPERATIVE SOIL SURVEY

Soil Survey Conference Proceedings

Orlando, Florida
January 31 - February 4, 1977

Proceedings of -----

NATIONAL TECHNICAL WORK-PLANNING CONFERENCE OF THE COOPERATIVE SOIL SURVEY

ORLANDO, FLORIDA

January 31 - February 4, 1977

REPRODUCED BY

Soil Conservation Service
United States Department Of Agriculture

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE, P.O. Box 2890

Washington, D. C. 20013

August 1, 1977

Advisory SOILS - 17

From: Klaus W. Flach
Assistant Administrator for Soil Survey

Re: Proceedings of the National Technical Work-Planning Conference January 31 - February 4, 1977

This transmits copies of the Proceedings of the 1977 National Technical Work-Planning Conference held at Orlando, Florida, January 31 - February 4, 1977.

These Proceedings are a record of the reports prepared by agencies cooperating in the national soil survey program and by committees appointed to report on selected subjects. This record does not necessarily reflect official views, although many of the ideas and methods that are discussed may be adopted officially.

Copies are being provided to you for distribution to cooperating agencies.

Klaus W. Flach
ACTG. Assistant Administrator
for Soil Survey

Enclosures

SO
TSC
WO (Without enclosure)

WO-AS-4
11-75

U. S. DEPARNENT OF AGRICULTURE
SOIL CONSERVATION SER

INITIAL
DISTRIBUTION AND CHECK LIST
Proceedings of the **National** Technical Work-Planning Conference

STATE OFFICES	
Alabama	4
Alaska	2
Arizona	16
Arkansas	5
California	20
Caribbean Area	
Colorado	8
Connecticut & R.I.	7
Delaware	2
Florida	10
Georgia	8
Hawaii	5
Idaho	3
Illinois	3
Indiana	7
Iowa	10
Kansas	4
Kentucky	7
Louisiana	3
Maine	5
Maryland	6
Massachusetts	3
Michigan	7
Minnesota	10
Mississippi	6
Missouri	5
Montana	8
Nebraska	6
Nevada	8
New Hampshire	4
New Jersey	5
New Mexico	6
New York	7
North Carolina	6
North Dakota	5
Ohio	6
Oklahoma	4
Oregon	11
Pennsylvania	7
Rhode Island	
South Carolina	5
South Dakota	5
Tennessee	5
Texas	12
Utah	5
Vermont	6
Virginia	5
Washington	8
West Virginia	3
Wisconsin	10
Wyoming	6
Puerto Rico	4

TSC'S	
Lincoln, Neb	8
Portland, Ore.	12
Broomall, Pa.	8
Fort Worth, Tex.	8
CARTOGRAPHIC UNITS	
Hyattsville, Md.	
Spartanburg, S. C.	
OTHER	

TABLE OF CONTENTS

INTRODUCTION

The National Soil Survey Conferences are designed to provide a forum for discussion of scientific and technical questions on soil classification, description, genesis, morphology, interpretations, and use. Reports of these conferences after trials and tests in the field become the basis for revising our procedures.

The conference is made up of representatives from the National, Regional, and State Offices of the Soil Conservation Service; other federal agencies having an interest in the soil survey program; and the Land-Grant Universities. In addition, Belgium, Canada, France, the Netherlands, and the International Institute of Tropical Agriculture had representatives at our conference this year.

These proceedings indicate trends in thinking and progress of work. Thus, they do not necessarily represent official views, although many of the recommendations ultimately may be adopted.

Klaus W. Flach
Assistant Administrator
for Soil Survey

NATIONAL SOIL SURVEY CONFERENCE

January 30 - February 4, 1977

Participants

Cliff J. Acton
Soil Research Institute
Canada Dept. of Agriculture
K.W. Neatby Bldg.
Carling Avenue
Ottawa, Ontario KIA OC6

B. L. Allen
Prof. of Soils and Geology
Dept. of Agronomy
Texas Tech University
Lubbock, Texas 79409

James R. Anderson
Chief Geographer
USGS - Nail Stop 710
Reston, Virginia 22092

William E. Austin
State Conservationist, SCS
Federal Building
P. 0. Box 1208
Gainesville, Florida 32601

F. H. Beinroth
Asst. Prof. Soil Science
Dept. of Agronomy & Soils
University of Puerto Rico
Mayaguez, Puerto Rico 00708

Wesley R. Booker
Gureau of Indian Affairs
1951 Constitution Ave., N.W.
Washington, D. C. 20245

James F. Brasfield
Asst. State Soil Scientist
SCS, Federal Building
Gainesville, Florida 32602

Carl W. Carlson
Agri. Research Service
Room 330A
Administration Bldg.
Beltsville, Maryland

Oliver R. Carter
Soil Scientist, SCS
Room 239A - FCB-1
Hyattsville, Maryland

E. J. Ciolkosz
Asst. Prof., Soil Genesis
The Pennsylvania State Univ.
University Park, Pennsylvania 16802

Ida Cuthbertson
Community Planner
Resource Development Div., SCS
Room 6129 So. Agri. Bldg.
Washington, D. C.

Raymond B. Daniels
Director, Soil Survey Investigations Div.
Soil Conservation Service
P.O. Box 2890
Washington, D. C. 20013

J. M. Davidson
Prof. of Soil Phys.
University of Florida
107 Newell Hall
Gainesville, Florida 32611

R. M. Davis
Administrator, SCS
P.O. Box 2890
Washington, D. C. 20013

James A. DeMent
Assistant Principal Soil Correlator
S-TSC, SCS
Fort Worth, Texas 76115

LeRoy de Moulin
Bureau of Land Management
18th & C Streets, N.W.
Division of Watershed (350)
Washington, D. C. 20240

Raymond I. Dideriksen
Director, Land Inventory & Monitoring
Soil Conservation Service
P.O. Box 2890
Wsshington, D. C. 20013

Richard H. Dierking
Chief, Soil Classification &
Mapping Branch, SCS
Room 239A -FCB-1
Hysttsville, Maryland 20782

Charles F. Eno
Prof., Soil Microbiology & Chem.
University of Florida
106 Newell Hall
Gainesville, Florida 32611

R. S. Fsrnhsm
Prof. Soil Survey & Organic Soils
University of Minnesota
St. Paul, Minnesota 55101

T. E. Fenton
Prof. Soil Classification
Iowa State University
Ames, Iowa 50010

Klaus W. Flsch
Assist. Admin. For Soil Survey
Soil Conservation Service
P.O. Box 2890
Washington, D. C. 10013

Donald G. Fohs
Chief, Soils & Exploratory
Techniques Group
Office of Research, FHA
U.S. Dept. of Trans.
Washington, D. C. 20591

Westal W. Fuchs
Assistant Director of Operations
Soil Conservation Service
P.O. Box 2890
Washington, D. C. 20013

Jerome A. Gockowski
Director of Cartographic Div.
Soil Conservation Service
P. 0. Box 2890
Washington, D. C. 20013

Darrell G. Grice
State Soil Scientist, SCS
29 Cottage Street
Amherst, Massachusetts 01002

Robert B. Grossman
Soil Conservation Service
2i Mumford Hall
Department of Agronomy
Univeristy of Missouri
Columbia, Missouri 65201

Oivs R. Hsrju
Civil Engineer
Applied Sciences Branch
Division of General Research
Engineering & Research Center
Denver, Colorado 80225

R. D. Heil
Assoc. Prof. Soil Genesis Classification
& Survey Land Planning
Department of Agronomy
Colorado State University
Fort Collins, Colorado 80523

C. Steven Holzhey
Head, Soil Survey Investigation Unit
Soil Conservation Service
Room 345, Federal Building
U. S. Court House
Lincoln, Nebraska 68508

Richard C. Huff
State Soil Scientist
Soil Conservation Service
Room 440, Alexander Young Bldg.
Honolulu, Hawaii 96813

H. Ikawa
Assoc. Prof., Soil Genesis and Class.
Department of Agronomy & Soil Science
University of Hawaii
Honolulu, Hawaii 96822

Robert W. Johnson
State Soil Scientist, SCS
Federal Building
P. 0. Box 1208
Gainesville, Florida 32602

William M. Johnson
Deputy Administrator for
Technical Services
Soil Conservation Service
P.O. Box 2890
Washington, D. C. 20013

A. J. Klingelhoets
State Soil Scientist, SCS
4601 Hammersley Road
P. 0. Box 4240
Madison, Wisconsin 53711

Joe Kubota
Soil-Plant-Animal Relations
Specialist, SCS
U. S. Plant, Soil & Nutrition
Lab.
Tower Road
Ithaca, New York 14850

Kermit Larson
Forest Service
Watershed & Minerals Area
Management
USDA, Room 810, RP-E
Washington, D. C. 20250

James H. Lee
State Soil Scientist, SCS
Parkade Plaza Shopping Center
P. 0. Box 459
Columbia, Missouri 65201

Victor G. Link
Director, Soil Survey Operations
Soil Conservation Service
P. 0. Box 2890
Washington, D. C. 20013

William J. Lloyd
Chief Forester
Ecological Sciences & Technology
USDA, SCS
P. 0. Box 7.890
Washington, D. C. 20013

Marco L. Markley
State Soil Scientist, SCS
1370 Hamilton Street
P. 0. Box 219
Somerset, New Jersey 08873

J. Vernon Martin
Director, S-TSC, SCS
P. 0. Box 6567
Fort Worth, Texas 76115

John E. McClelland
Director, SS Classif. & Correlation Div.
Soil Conservation Service
P. 0. Box 2890
Washington, D. C. 20013

Donald E. McCormack
Director, SS Interpretations Div.
Soil Conservation Service
P. O. Box 2890
Washington, D. C. 20013

Marvin C. Meier
Forest Service
Watershed & Minerals Area Management
USDA, Room 810 RP-E
Washington, D. C. 20250

Eilif Miller
Room 441-W, USGA
Cooperative State Research Ctr.
Washington, D. C. 20250

Frank Moormann
International Inst. of Tropical Agri.
Oyo Road, P.M.B. 5320
Ibadan, Nigeria

Edmund A. Naphan
State Soil Scientist, SCS
Room 308, U.S. Post Office Building
P. 0. Box 4850
Reno, Nevada 89505

W.D. Nettleton
West Liaison
National Soil Survey Lab.
Federal Building
U.S. Court House
Lincoln, Nebraska 68508

Joe D. Nichols
Principal Soil Correlator
Soil Conservation Service
P. 0. Box 6567
Fort Worth, Texas 76115

Gerald Olson
Assoc. Prof., SS Interp
Department of Agronomy
Cornell University
Ithaca, New York 14853

Harold I. Owens
Agronomist & Soil Conservationist
Extension Service
Room 5925 So. Agri. Bldg.
Washington, D. C. 20250

H. F. Perkins
Prof., Soil Fertility
Room 3111, Miller Plant Science Bldg.
Department of Agronomy
University of Georgia
Athens, Georgia 30602

W. D. Peters
Div. of Planning Coordination
Engineering & Research Center
Bureau of Reclamation
P.O. Box 25007
Denver, Colorado 80225

James C. Powell
Chief, SS Publications Branch
Soil Conservation Service
Rm. 253, FCB-1
Hyattsville, Maryland 20782

Thomas W. Priest
State Soil Scientist, SCS
P. 0. Box 17107
Denver, Colorado 80217

John D. Rourke
Principal Soil Correlator
Soil Conservation Service
1974 Sproul Road
Broomall, Pennsylvania 19008

Richard H. Rust
Prof. Soil Surv and Physiol Chem Soils
Soil Science Department
University of Minnesota
St.Paul, Minnesota 55101

Edward H. Sautter
State Soil Scientist, SCS
Mansfield Professional Park
Route 44A
Storrs, Connecticut 06280

Francis M. Scilley
State Soil Scientist, SCS
200 Federal Bldg. 6 U.S. Courthouse
316 North Robert Street
St. Paul, Minnesota 55101

Pierre Segalen
ORSTOM
70-74 Route d' Aulnay
93140 BONDY
FRANCE

Morris E. Shaffer
State Soil Scientist, SCS
Federal Building
355 East Hancock Avenue
Athens, Georgia 30601

J. A. Shields
Soil Research Institute
Canada Dept.of Agriculture
K.W. Neatby Bldg.
Carling Avenue
Ottawa, Ontario KIA 0C6

David F. Slusher
Assistant Director, SS Interp. Div.
Soil Conservation Service
P. 0. Box 2890
Washington, D. C. 20013

R. M. Smith
Prof. of Agronomy
West Virginia University
Morgantown, West Virginia

Maurice Stout, Jr.
Principal Soil Correlator, SCS
Federal Building- U.S. Courthouse
P.m. 345, 100 Centennial Mall, North
Lincoln, Nebeaska 68508

Rene Tavernier
International Training Center
Rozier 44
State Unibersity - Ghent
9000 Ghent
Belgium

K. R. Tefertiller
Vice Pres. for Agr. Affairs
1008 McCarty Hall
Gainesville, Florida 32611

John A. Thompson
Soil Scientist, SCS
Soil Data Storage & Retrieval Unit
Room 233A-FCB #1
Hyattsville, Maryland

Arville B. Touchet
State Soil Scientist, SCS
3737 Government street
P. 0. Box 1630
Alexandria, Louisiana 71301

Robert I. Turner
Asst. Principal Soil Correlator
MW-TSC, SCS
Federal Building
100 Centennial Mall, North
Lincoln, Nebraska 68508

K. R. van Lynden
Supervisor for Classification
and Interpretations
P. 0. Box 98 Wageningen
11, Marijkeweg
The Netherlands

Henry 6. Waugh
Bureau of Indian Affairs
5301 Central Avenue, N.E.
Albuquerque, New Mexico 87108

G. J. W. Westerveld
Head, Soil Survey Division
Staring Building Wageningen
P.O. Box 98
Wageningen, The Netherlands

F. C. Westin
Prof. Soil Survey
Dept. of Plant Science
South Dakota State University
Brookings, South Dakota 57006

E. P. Whiteside
Prof. Soil Genesis Classif.& Yapping
Dept. of Crop & Soil Science
Michigan State University
East Lansing, Michigan 48823

Larry P. Wilding
Prof. of Soil Minerals
Department of Agronomy
The Ohio State University
Columbus, Ohio 43210

J.Melvin Williams
Principal Soil Correlator
W-TSC, SCS
511 N. W. Broadway
Portland, Oregon 97209

John E. Witty
Assistant Principal Soil Correlator, SCS
1914 Sproul Road
Broomall, Pennsylvania 19008

Work Planning Conference

of the

National Cooperative Soil Survey

January 30 - February 4, 1977

AGENDA

Sunday January 30		
3:00-6:00 p.m.	Registration	Lobby Miriam H. Plastow, Registrar
Monday January 31		
7:45-8:30 a.m.	Registration	Grove Room
	General Session - Grove Room Klaus W. Flach, Chairman	
8:30 a.m.	Conference Opening Welcome to Florida	William E. Austin State Conservationist, SCS
	Conservation Southern Style	Slide Presentation
	Reorganization of the Soil Conservation Service	William M. Johnson Deputy Administrator for Technical Services
	Role of Technical Service Centers of SCS	J. Vernon Martin, Director South Technical Service Center
	Role of the University in the Soil Survey Program	Charles F. Eno, Chairmen Soil Science Department University of Florida
10:00 a.m.	Recess	
10:20 a.m.	The South Revisited	Slide Presentation
	Soil Survey -Belgium	Rene Tavernier, Professor of Soils, Geology Institute
	Soil Survey -Canada	John A. Shields, Western Correlator, Soil Research Institute, Canada Agriculture

Monday
January 31 (continued)

	Soil Survey -France	Pierre Segalen, Inspector General of Research ORSTOM
	Soil Survey -Netherlands	G.J.W. (Wil) Westerveld Head Soil Survey Division Netherlands Soil Survey Institute
	Soil Survey -International	Frank Moormann, Soil Scientist Institute of Tropical Agriculture, Ibadan, Nigeria
11:30-12:30	Lunch	
12:30	Soil Surveys for Economic Planning and Development	Kenneth R. Tefertiller Vice President for Agricultural Affairs University of Florida
	Regional Conference Reports North Central	Fred C. Westin, South Dakota State University
	Northeast	Richard M. Smith, West Virginia University
	Southern	H. F. (Jack) Perkins University of Georgia
	Western	Robert D. Heil Colorado State University
	Dept. of Agriculture Agriculture Research Service	Carl W. Carlson Assistant Administrator
	Cooperative State Research Service	Eilif Miller, Principal Soil Scientist
	Extension Service	Harold T. Owens, Agronomist
	Forest Service	Kermit Larson, Soil Leader, National Forest System
	Dept. of Interior Bureau of Indian Affairs	Wesley R. Booker Soil Conservationist

	Bureau of Land Management	LeRoy de Moulin Soil Scientist, Watersheds
	Bureau of Reclamation	William D. Peters Division of Planning Coordination
	Geological Survey	James R. Anderson Chief Geographer
	Dept. of Transportation Federal Highway Admin.	Don Fohs, Chief Soil and Exploratory Techniques, Office of Research
3:00 -	Recess	
3:20 - 5:15	Reports from SCS Divisions Programs Group	
	Resource Development Div.	Ida Cuthbertson

Tuesday
February 1

8:15 - 11:30	Preparation of committee reports by committee members and other conference participants. Participants not assigned to committees are encouraged to join in the deliberations of committees of their choice both in the morning and afternoon sessions.	
Committee #3	Waste Treatment on Named Kinds of Soils	Palm Room
#5	Soil Surveys in Woodlands, Rangelands, and Wildlands	Oak Room
#6	Interactions between Soils and Fertilizer Responses	Cypress Room
#7	Organic Soils	Pine Room
11:30	Lunch	
12:30	Technical Services Group Field Services	
	Cartographic	Jerome A. Gockowski
	Ecol. Sciences & Tech.	William J. Lloyd

	Inventory & Monitoring	Raymond I. Dideriksen
	Soil Survey Group	
	Soil Classification & Correlation	John E. McClelland
	Soil Survey Interp.	Donald E. McCormack
	Soil Survey Investigations	Raymond B. Daniels
	Soil Survey Operations	Donald E. McCormack
	Preparation of committee reports	
Committee #1	Modernizing Soil Surveys	Oak Room
#2	Improving Soil Survey Techniques	Cypress Room
#4	Water Movement in the Soil Landscape	Palm Room
*	Committee on Soil Taxonomy, Classification of Alfisols and Ultisols with Low Activity Clays, and other discussions of Soil Taxonomy.	Pine Room
5:15	Adjourn	
Wednesday February 2		
8:15	Committee reports and Discussions	Grove Room
Committee #3	Waste Treatment on Named Rinds of Soils	
9:45	Recess	
10:00		
Committee #5	Soil Surveys in Woodlands, Rangelands, and Wildlands	
11:15	Lunch	

*Not a formal committee of this conference.

12:oo	Field trip to observe potted plant industry, orange producing area, and experimental areas with winter vegetables on organic soils and ornamental plant production.	
5:30	Adjourn	

Thursday
February 3

8:15	Committee reports and Discussions	Grove Room
Committee 84	Water Movement in the Soil Landscape	
9:45	Recess	
lo:oo		
Committee #1	Modernizing Soil Surveys	
11:30	Lunch	
12:30		
Committee #6	Interactions between Soils and Fertilizer Responses	
Committee #2	Improving Soil Survey Techniques	
3:00	Recess	
3:20	Committee #2 continued	
Committee #7	Organic Soils	
5:15	Adjourned	

Friday
February 4 Grove Room

8:15	Soil Survey for Changing Needs	Mel Davis, Administrator, scs
8:45	Recommendations for 1979	John E. McClelland, Committee Chairman*

*Committee consists of Kermit Larson, John Rourke, Mike Stout, Gene Whiteside, and Jack McClelland (Chariman). Contact any of these during the conference relative to suggestions for the next conference for format and subject material.

	Potentials of Tropical Soils	H. (Ike) Ikawa, University of Hawaii
	Report on progress of International committee on Classification of Alfisols and Ultisols with Low Activity Clays	Frank Moorman
	Prime Farmland	Slide Presentation
	Remarks	J. Vernon Martin
	Conference Summary	Klaus W. Flach
11:30	Adjourn	

CONFERENCE PRESENTATIONS

Welcome To Florida

William E. Austin*

Florida Statistics

A. Population: Total population for Florida is approximately 8.5 million. Most rapidly growing state in the nation. Four centers of population: Jacksonville, Miami Area (Gold coast), Orlando, and Tampa-St. Pete.

B. Agriculture: On-farm income for 1974-75 was 2.2 billion dollars; retail sales of over 6 billion; approximately 860,000 acres of citrus; 16.2 million acres commercial forest; 13.2 million acres in other farms and ranches out of a total 36 million are in the state.

Citrus: Florida produces 54% of world's grapefruit;
95% of world's orange concentrate;
80% of world's total processed citrus.
(We plan to cross the central Florida ridge on the tour to give you an idea of the vast citrus areas of the state.)

Vegetables, Potatoes, Melons, and Strawberries:

Florida's total acreage. production, and value of fresh market vegetables was second in the nation. (We produce most of the fresh market vegetables you eat in the winter.)

Florida was first in production of fresh market snapbeans, cabbage, Sweet corn, cucumbers, egg-plant, escrole, and watermelons. (The tour on Wednesday will stop at one of the many vegetable processing operations in central Florida.)

Dairy: One hundred percent of milk produced in Florida is sold as fluid milk products in the state, our production is 9,889# milk/cow. The-417 daries in the state average about 475 cows each.

Beef Cattle: Florida ranks second in number of beef cows among States east of Mississippi River and 11th in nation.

*State Conservationist, Gainesville, Florida

Ornamental Horticulture: Florida has one of the fastest growing ornamental horticulture industries in the country. (We hope to show you one of these operations on the tour.) First in production of foliage plants and second in production of flowers We are first in the production of ferns.

Forestry: 16.2 million acres of commercial forests. Florida is 8th in the nation in pulp production. (Most of our forest is in the norhtern part of the state; however, they are experimenting with Eucalyptus for pulp in the south.)

Tobacco: Ranks second in value among Florida's field crops (flue-cured and shade types); returns to growers 36.6 million dollars annually.

Sugar Cane: Florida is second in the nation in sugar cane output; valued at over SO million dollars; grown on the organic soils in the Everglades.

Purebred Horses: Thoroughbred industry is third in the nation in foals born. Florida has several Kentucky Derby winners.

Honey: Florida is second in the nation in value and production of honey.

C. Resource Areas: We have four district landscapes in Florida: (1) Southern Coastal Plain (upper pan handle); (2) Gulf, Atlantic, and Southern Flatwoods; (3) Central Florida Ridge; and (4) Everglades. Elevations range from sea level to around 270 in pan handle.

Florida is split between thermic and hyperthermic soil temperature which corresponds to the northern extent of citrus. The line runs approximately east and west through Gainesville.

D. SCS Operations:

SCD'S cover entire state except Dade, Collier, and Monroe counties.

We service approximately 15,000 - 20,000 land users each year.

Twenty approved watershed projects; 7 completed.

NE Gulf River Basin Study, which includes north Florida and southern Georgia and Alabama.

Three RC&D Projects - all in pan handle

Plant Materials Center at Brooksville where plant materials are developed for use in the southeastern United States.

Conservation Operations:

In addition to working with farmers and ranchers, we have a big workload in working with units of government, reviewing subdivision plans; I&E's for spreading effluent on the land; DER; Department of Health evaluating septic tank and landfills sites; etc. To give you an idea of the magnitude of this work, one soil scientist in North Florida made 58 on-site evaluations during first one-half of last FY.

E. Soil Survey in Florida

In 1973, at our annual state soil survey work planning conference, we were urged to develop a plan to complete the survey in the state within a lo-year period. The plan was to show funds and manpower required to do the job.

As a result, a lo-year master plan was developed jointly by SCS, University of Florida, and Florida Association of Conservation Districts. The State Association had adopted the plan as one of its prime objectives.

The plan was presented to the State Legislature, and subsequently funded, as a line item in the State Department of Agriculture and Consumer Services. To date the state has appropriated 1.5 million dollars for soil surveys. This year the Legislature appropriated $352,000.

County governments have also contributed funds to the soil survey program, adding another $100,000 annually to the program. Eighty percent of all acceleration funds are directed to SCS for field operations, and 20 percent to the University for laboratory characterization.

While we have not been able to accelerate to the extent outlined in the Plan, we are exceeding our previous mapping goals by more than 50 percent annually. Another benefit of the accelerated program is the publicity that soil surveys have received, especially among the state and local lawmakers, planners, and others.

People are more and more aware of the uses that can be made of soil survey information. We are working with many groups and agencies to incorporate soils information into land management decision. For example, the state has identified the need for basic soil survey information in the agricultural and land use elements of the State Comprehensive Plans as well as the need to recognize and conserve prime and unique, farmland. The state division of planning is developing interpreting maps from county general soil maps using a new concept of soil interpretations. These maps show the "probability" of slight, moderate, or severe limitations for various aand uses. We have worked with the Seminole County Planning Department to come up with "Soil Potentials" for various land uses. The County has published this data and is using it in its day-to--day operations. We are also working toward developing management practices to overcome soil limitations, in order to attain soil potentials.

We could cite many more examples of how soil survey information is being utilized and manipulated. I know many of you have similar examples in your state or county; the point is that soil surveys are now recognized as an essential tool in land use planning and management.

I would conclude by saying that I feel we need to be alert to the needs of the users of soils information, and gear our program to meet these needs. We need to ask them how we can improve our maps and interpretations; then do our best to meet these needs. Our program must be flexible and dynamic.

One Last Comment-- I am impressed with the spirit of cooperation among the various agency representatives attending this conference. Everyone seems interested in working toward improving the soil survey. This cooperative spirit and team effort are certainly evident in soil survey program in Florida. We feel that whatever we have achieved in Florida has been because of the excellent working relationships we have among the SCS, University of Florida, the USFS, and the various state and local agency people involved in making and supporting the soil survey.

At this time I'd like to introduce a short slide presentation we developed, showing our work with plant materials in an attempt to stabilize the eroding beaches.

Reorganization of the Soil Conservation Service

By- William M. Johnson, Deputy Administrator
for Technical Services, SCS, Washington, D.C.

Thank you Klaus. I didn't guarantee to explain the changes in the SCS Organization. I said I would describe them. Explaining them is something else, you know. As a matter of fact, I don't know that they really need explanation. Whenever you have a change in administration, whether it be in your own agency or the entire federal establishment, or when a certain period of time has passed, reorganization is inevitable.

You can read accounts of Roman field commanders who complained about the fact that every time they seemed to have their organization shaken down, well trained and disciplined, and thoroughly understanding of their tasks, they were reorganized. I am not trying to point out any parallel with our situation, but it is a fact that no bureaucracy maintains itself in the same way indefinitely. I don't want to get into the discussion of the philosophy of the reorganization. I will talk about it a little bit, but I have some other things to say.

I tried to count the work-planning conferences, too. One of the foibles of people as they grow older is to look backward more frequently than they look forward, and I've been trying not to do that, but I did try to count the work-planning conferences and this must be about the twenty second one. We met at this same place, in this same room exactly two years ago. Since that time soil scientists have made a lot of progress. Many things have happened that affect soil survey in this country and in other countries. In these two years, Professor Tavernier has completed his new building for his Institute in Ghent and is in the process of moving into that beautiful modern structure at the edge of the campus. Another thing that has happened is that the weather has turned lousy in Florida. I don't know who is to blame for that, but I'm sure that it will improve as the week goes on. Dr. Kellogg still lives in Hyattsville. I know he wishes he were here. In fact, he said not so long ago, "Maybe, by God, maybe I'll just come down," and I said, "I wish you would. The people would like to see you."

Charles is in quite good health. He is a bit thin; he had some illness last summer and fall and spent a few days in the hospital. He recovered from that and he's active. We writes; he keeps up his correspondence; he gives a few lectures; he is working on another book; and he hasn't lost his interest in soil survey--not that I need to tell you that. He sent his greetings to all of you and his admonition to do good work, and I know that that isn't necessary either, but that's his message. I know he will be glad to hear from those of you who know him. He almost froze to death the other night. He burns oil in his house and he is on an automatic refueling schedule. With the bad weather there was the necessity to put on additional truck drivers. The driver that “as supposed to deliver at his house “as about three days late. The Kelloggs were nearly out of oil and when the driver did come, it was 2:30 in the morning. But Charles and Lucille got up and made coffee for the truck driver and helped him as much as they could, which is more or less typical of the two of them.

Most of you have attended these sessions before. Some of you have attended quite a few of them. It’s a bit like old hone week here. But for quite a few of you, this is the first time I have seen you at one of these meetings, and this is the first time, I think, that we have had attendance from those of the majority persuasion. I am delighted to see this. For you ladies who are honoring us with your presence this morning, I hope this is the beginning of a pronounced trend. The participation of soil survey agencies and soil scientists outside the United States has broadened, and I think that’s a good sign. We have a good deal to learn from our colleagues in Europe, South America, Africa, and Asia, as well as from our traditional cooperators to the North in Canada, and more recent cooperators to the South in Mexico.

At long last, Soil Taxonomy has come off the press. After 25 years of effort, that’s got to be one of the longest gestation periods for a book that I know anything about. Twenty-five years--Jack McClelland, you can get up and take a bow. You were the one who finally kicked it off. It has been distributed throughout the U.S., and pretty well all over the world. And in this period since our last meeting, the world’s energy, economic, and food problems have worsened as they were predicted to do. That has a great deal of implication for us, both in terms of the funding and support that we get for our work, and for the problems we have to deal with.

In the United States, we have accelerated soil mapping and the rate of soil survey publication, bringing us nearer to the day when we shall have reliable soil surveys of all our land. As we approach that time, we must be thinking about the changes in organization, the changes in emphasis, the changes in training, and the changes in communication that will be required.

To mention the matter of the reorganization of the Washington office of the Soil Conservation Service, I want to emphasize that it is a Washington office reorganization and it doesn’t have all that much impact on the work of the cooperative soil survey, nor particularly the work of this conference. Just for general interest, so that you will know why Klaus is in charge of this conference and not me and why some of the other changes have taken place, I will talk about it briefly.

Previously, in our Washington office we had four deputy administrators, one for Water Resources, one for Field Services, one for Soil Survey, and one for Administration. Now we have three. We reshuffled some divisions, created some new ones, and organized them under three deputy administrators, who report directly to the Administrator of the Soil Conservation Service.

The three areas of activities are (1) Administration, (2) Programs, and (3) Technical Services.

Administration includes procurement, budget and finance, personnel, and program evaluation. It is under the leadership of Verne Bathurst.

Programs includes technical assistance under our Conservation Operations Programs-- river basin and small watersheds programs and resource conservation and development activities. Vic Barry is the Deputy Administrator for Programs. He has two assistant administrators, one for land resources programs and one for water resources programs. The various divisions that fall under them are the divisions with which Technical Services has the greatest interest, and we are fortunate to have some representatives of program groups with us at this meeting.

Technical Services is my responsibility. It includes 10 divisions under two assistant administrators. Dr. Flach looks after the Soil Survey portion and Paul Howard, Field Services. Under Field Services are the Cartographic Division headed by Jerry Cockowski; Economics Division, Mack Gray; Environmental Services Division, Glen Loomis; Engineering Division, Neil Bogner; Inventory and Monitoring Division, Ray Diderikson (who is here today), and Ecological Sciences and Technology Division, Tom Shiflet.

Ecological Sciences and Technology includes agronomy, range, biology, and woodland, and we have a representative of that division here--Bill Lloyd, our forestry expert.

In soils, the Classification and Correlation Division is headed by Jack McClelland. This is the division that deals with Soil Taxonomy, classification and correlation, and maintaining the records and reports related to those matters. The Soil Survey Operations Division is being looked after, on an acting basis, by Don McCormack. Don is also head of Soil Survey Interpretations. We are about to relieve Don of the Operations task. I am not at liberty to talk about the replacement yet, but you all know him and I think you will agree that we have made a good choice. Frank Carlisle has been acting as Director, Soil Survey Investigations Division, the research branch including laboratories and field operations. I cannot announce the new Director of that Division either, but he is present and probably the grapevine will tell you who he is before the week is over.

I am very much concerned about Soil Survey, and I will be concerned with the conference. And, since I started my career as a soil scientist on the end of a spade in the dear days beyond recall, when we used plane tables rather than air photos as a base, I'm not likely to lose my interest. But, now I have a chance to expand cooperation with other disciplines. We have had a tradition of good cooperation between soil survey and engineering; soil survey and the plant sciences--agronomy, forestry, range management, and biology. You may remember some of Dr. Kellogg's lectures about the importance of economics, and much of our work is reflected in the economics of farming or other land uses. Fortunately, the understanding of the uses of soil surveys and the relationships between soil survey and economics, land-use planning, land management, crop production, recreation, wildlife, production of timber for pulp or for housing or whatever are being investigated much more thoroughly and with a much larger group of people today, not only in this country but around the world, than ever before.

In the United States our cooperation with state agencies is growing all the time. Traditionally, our cooperation "as with land grant universities, particularly the agricultural experiment stations. But no" our cooperation is with state conservation commissions, state departments of taxes, health, highways, and transportation, with state environmental agencies and departments of agriculture. I can't name all the kinds of state agencies that are cooperating in soil surveys by providing money, manpower, supplemental expertise, and that are using these surveys to enhance their own programs. For example, Public Law 92-500, federal water quality: One of the sections, 208, requires that each state develop a plan for non-point source pollution control that affects farming and other land uses. Various state agencies are charged with responsibility for it. Through the Soil Conservation Districts the Soil Conservation Service is very much involved, along with some other federal agencies in many states. And it comes back to the kind of soil as shown on our maps and characterized in our reports. With your help, we can advise these cooperative state-federal operations that are trying to develop plans to control this kind of pollution. It's an extremely important use of soil surveys. We don't have any federal Land-use planning laws, and frankly, I would just as soon we didn't have any. But, we do have state laws and local laws about Land-use planning. Increasingly, these laws are becoming dependent on soil surveys, as they should, because the capability of the soil resources to perform under different kinds of land use without causing degradation of either the resource itself or the environment, is obviously extremely important, and the best possible source, of information on that subject is the soil survey.

State agencies are participating actively in the important farmland inventory. The identification of prime and unique farmland and the identification and delineation of other important farmlands are important statewide and locally. These inventories are causing interest; they will be extremely helpful to both federal and state agencies. The Council on Environmental Quality has issued a request to consider the impact of major federal action on our resources of prime farmland. For example, just last week I attended hearings most of one day at OMB on the subject of strip mine legislation in the parts of the United States east of the hundredth meridian. It is quite likely that the new strip mining legislation will have reference to prime farmland.

Many state agencies are helping us to accelerate the mapping and publication of surveys, and we welcome all of them. We are glad to have all the help we can get. Other federal agencies, mainly in agriculture, interior, and transportation, have been cooperating in the survey for many years, and the cooperation is increasing. ARS, Cooperative State Research Service, Extension Service, and the Forest Service, all have contributions to make, or have been making these contributions and they are increasing. I would mention particularly the recent agreement between Forest Service and SCS, growing out of the work of Mel Williams, Bill Wertz, Kermit Larson, and others in the Forest Service and in SCS, that developed this understanding between our agencies about what each is going to do in the area of soil survey and the strengthening df our cooperative effort. In Interior, Geological Survey, Bureau of Indian Affairs, Bureau of Land Management, and the Bureau of Reclamation have been traditional cooperators. We are getting more things going with each of them. We are using Geological Survey to provide us with orthophoto maps and with intermediate scale base maps for a lot of our activities. BLM is expanding its soil survey efforts. This causes us some problems. When other agencies contract with consulting firms to make soil surveys and then load all the extra correlation and other quality control work on scs, it causes a crunch in places, and I think we have some things we do need to work out. As Klaus mentioned, the old Bureau of Public Roads was a regular participant in this conference. We are delighted that the Federal Highway Administration people are now back in the fold and meeting and talking with us, because we've got a lot of things to say to each other. Besides them of course, NASA, NOAA, HUD, EPA, and CEQ have regular meetings with us, at least at the Washington level, and at regional and even state levels they are working out ways in which the soil survey can be helpful to them.

THE ROLE OF THE TECHNICAL SERVICE CENTER IN THE SOIL SURVEY PROGRAM

For you visitors from other countries and others who may not be familiar with Soil Conservation Service organization, let me explain that our agency has the country divided off into four parts, and each section has an office to provide specialized technical assistance and services to the states. This office, or facility, is called the Technical Service Center.

Our technical service center in Fort Worth has several units under one roof. They provide technical leadership and services in engineering, training, cartography, information, and soils, to name a few.

One of the main reasons for having a cartographic unit, plant sciences unit, soil correlation unit, and others under one roof is for easy exchange of information and ideas. I see our overall role as requiring an interdisciplinary approach to assistance to the states.

The soil survey programs, as almost everyone here knows, is not the exclusive property of any one agency. There are many from universities and agencies in Washington and in the field that must mesh efforts to make the National Cooperative Soil Survey happen.

But if you found yourself in a state agency office, or on a school campus, or research facility, and asked for directions to the national soil survey program, the answer you'd get would be "You can't get there from here."

Presentation by J. Vernon Martin, director, South Technical Service Center, Soil Conservation Service, Fort Worth, Texas, at the Work Planning Conference of the National Cooperative Soil Survey, Orlando, Florida, January 31, 1977.

Similarly, if a stranger found himself in Washington, and asked the way to the national soil survey, the answer would have to be, "You can't get there from here."

Let me hasten to add that I am not bad-mouthing the leadership roles that must be carried out at the university and field level, or the Washington level--because we couldn't have the national soil survey without you. But, I want to make the point that the TSC fills a unique role. We bring together the results of research and university leadership, the work of field soil scientists, and national leadership. If you ask us the way to the national program, we are in a position to point out the way.

In our role, the TSC Director and the Soil Correlation Unit head must constantly look in two directions.

First, we must look toward the field. We must give field people the utmost in support that will result in improved efficiency and accuracy of work. We must also innovate suggestions or methods that will increase soil survey production.

We must also look in the other direction: The TSC Director and the Soil Correlation Unit head must constantly keep the soil survey user in mind. The information must be delivered to the public with a combination of accuracy, usability, and timeliness.

This places on us the demand that we be scientific,. but we must also respect and serve the practicioners who need the soil survey information--the farmers, builders, planners, and others who want and need the information on which to base wise land use decisions which will result in a world built on sane principles, not just helter-skelter.

I think it should be obvious that we can't do our part just by following some dry policy statement that says we will "furnish technical assistance." To carry out our role, the Technical Service Center units, and especially the soil correlation unit, must work together with each other and national and state leaders to achieve a dimension of service and leadership that is not present at other levels.

Here are some highlights that will illustrate my views on the leadership role we have:

* The big thing is quality control. States have responsibility for maps and manuscripts, but we must spot-check to assure that they are of acceptable quality before they are submitted for printing. The cartographic unit of the TSC also has expert-help making spot checks so that when soil survey maps get into the hands of the user, he or she is assured of an accurate, usable document.

Some of you may see this as an oversimplification. but we can lump the soil correlation function of the soil correlation unit under the heading of quality control--because soil correlation can be defined as the careful review of soil scientists' work to meet pm-set standards.

This work requires people who are not only top hands in the technical sense, but who have a conceptual view of their assignment. In other words, the correlation and spot checking include a factor of human leadership which can give close individual attention while at the same time maintain an overview of what we are trying to do with the national soil survey program. This isn't easy. We know our role requires a lot of our people, but we have the kind of people who meet the challenge.

* Another highlight of TSC leadership is in the preparation and technical review of manuscripts. Most of you know that not too many years ago, it was felt that to achieve the quality needed in these documents, each had to be absolutely tailor-made. It was like producing an automobile by machining each part separately, and that was a slow and expensive process.

The nature of the national soil survey includes an inherent problem that has been with us ever since Hugh Bennett was a student trainee-and that problem is production. In recent years, we've found that we can use some of the parts of our soil surveys from a central supplier, and, with just a little bit of hand-fitting, produce a serviceable document quicker and cheaper. In 1965, we were clearing only about one manuscript a month in Fort Worth. This year we will clear 54.

This has not been done by adding more people, but by using technology to achieve objectives. Working with universities and others, the South correlation unit innovated the use of computers in manuscript preparation. We use a combination typesetter-computer that greatly reduces the burden of retyping manuscripts.

Our role in the production of manuscripts has been enhanced by the addition of a technical editor. His most valuable contribution, by the way, may not be to edit, but to train soil survey party leaders to do a better job of writing in the field.

I wouldn't want you to think we have achieved this increase in production without making some sacrifices. Our TSC soil scientists are having less time for reading and preparing papers. Also, soils investigations and training have been curtailed.

* This opens up the subject of our role as trainers of soil scientists. This is something that, in my view, must have across-state-lines leadership for the greatest effect. If all soil science training took place within one state, there would be a great problem of provincialism. our soil correlation unit employees like to conduct training on a face-to-face basis, sometimes in the field, and sometimes in our own facilities. But all training can't be accomplished this way. Our Employee Development Unit arranges two formal courses in soils each year--one in soil basics, and one in soil correlation. The faculty comes from the soil correlation unit, universities, and from our cartographic unit, plant sciences unit, materials testing, and other units.

* One of the functions of the TSC which is reflected in our role in the national soil survey is what we might call the "confluence" function. I've already touched on our role of translating Washington to the field and the field to Washington--but our role goes one step further--we translate the field people to each other. If a soil scientist in Alabama discovers a time-saving trick, we see that soil scientists everywhere find out about it. In the world of soil science, es I have mentioned, it is desireable and often absolutely necessary to give training in the field. Our soil correlation unit and others in the TSC carry out this responsibility along with other travel and duties. Good opportunities for exchange of information among the states are generated. We must also make sure that the confluence of effort among the states is orderly. One of the important things we do along this line is to help the states schedule so that soil surveys will be coordinated in a systematic, smooth flow of completed reports.

This confluence function is also at work among co-workers in the technical service center. The soil series descriptions and interpretations have improved since it became an interdisciplinary responsibility. Series descriptions and interpretations utilize the TSC forester, agronomist, engineers and others as necessary. So if you see a series description including what we think a woodland soil will do with certain species, you can be assured that it has knowledgeable input by a highly-qualified forester; or if it is an estimate of cotton production, you know an agronomist has approved it.

* The ultimate measure of soil surveys is their use. This brings in the need for informing the public. Our Washington office has outdone itseif in recent years in the production of effective informational materials on the use of soils information. In the TSC, our role includes giving help to states in information programs for the purposes of achieving fuller use of soil surveys. One special effort was right here in Florida. When the state conservationist wanted to accelerate public participation and understanding of soil surveys, he decided to use television public service announcements. Our TSC information office worked with the Florida information officer and several spots were made. Although they were made over two years ago, I saw several on television here in Florida last year. They've received heavy use.

Now as I wind down this talk, I want to point out a thread of thought that runs through this whole thing--that is the concept of constant change. The researching, field work, publication and distribution of soil surveys is not static in any way. It is a dynamic program that requires the best possible input. Rapid land-use changes, critical production of sediment, the management of prime farmlands, and other critical land use issues create a
a steady pressure on us to produce soil surveys and get them to the user.

We have come a long way in the past few years, and we haven't accomplished this progress without plenty of problems--but as I look to the future, I can offer no advice except that we must do still better. The need and demand is not going to go away. On the contrary, with improved education of the public and acceptance of soil surveys, there will be increased demands.

All this means that we can never settle down to a "normal" tempo in the national soil survey program. However successful we think we've been in anticipating the future and in making long-range plans, we must continually try to do better. There are going to be changes, hazards, and roadblocks. On top of this there will be demands created by new uses for the soil survey information that we can't even dream of now.

I don't mean for this to sound like I take problems lightly, but nevertheless, leadership achieves by brushing aside obstacles to progress. This is what we must do. We must let nothing stand in the way of keeping a continuous flow of soil survey reports to those who want and need them.

Whatever burdens these increased demands create, we cannot look on them es problems, but as a form of success. Because soil surveys are of no value for their own sake--but become of value only as people use them to make intelligent decisions on how they will use and treat the soil so that our future world will be built on wise land-use principles.

Role of the University in the Soil Survey Program[1]

Charles F. Eno, Chairman
Soil Science Department
University of Florida
January 31, 1977

It is a pleasure formeto discuss the role of the university in the soil survey program today. I say today, because 15-20 years ago the role would have been much different and therefore less exciting to consider. At that time, in many states, including Florida, the Soil Conservation Service (SCS) and the state were often competing in the survey operation; our roles in the program were not clear. Often State soil surveyors would be in one County and SCS surveyors in the next with little or no coordination. Yes, the relationship of SCS and the universities in this program has changed--It has changed from one of Competition to one of Cooperation. Because I am at the University of Florida, permit me to use some examples from our program.

In our State, the role has been rather specifically stated in a legislative act passed in 1941:

The Florida Agricultural Experiment Stations role is based upon the first legislative declaration of support for soil surveys. The State Legislature in 1941, in Chapter 604, entitled "General Agriculture, Horticulture, etc., Laws" enacted the following:

604.01 State-wide soil survey and mapping; In the declaration of policy, they said--A thorough and careful survey and mapping of the soils of Florida is hereby declared as a matter of legislative policy which shall be basic to:

1. The development of intelligent research programs on the agricultural potentialities of the soils of the state;

---

[1]Presented before the Work Planning Conference of the National Cooperative Soil Survey. Orlando, Florida. January 30-February 1, 1977

2. The organization of effective soil conservation and land-use planning programs;
3. Agricultural extension and home demonstration work;
4. Highway and secondary road planning;
5. Establishment of equitable land tax assessments;'
6. Agricultural teaching;
7. The development of a sound body of helpful agricultural information for nationwide distribution to prospective land owners [Note: this calls for a national mechanism); and
8. A number of other social and agricultural enterprises of broad public interest.

The law further states:

> "The Agricultural Experiment Station of the University of Florida shall administer this law and shall be responsible for the general supervision of this cooperative enterprise between and among federal, state, county, and local agencies; and that it be charged with the duty of developing an energetic soil survey program for the state accordingly as funds are made available for this purpose from federal, state, county, or other sources."

In actual practice now, the SCS and Soil Science Department personnel cooperatively survey the soils of the State. Basically, SCS does the field work and the Soil Science Department conducts the laboratory-investigations. The field reviews, correlation, and writing of soil survey reports are done cooperatively. The SCS produces the maps, prints the text, and issues the final report. The reports are distributed by State and Federal agencies.

Inputs by the Florida Agricultural Experiment Stations are made through the Soil Science Department and are constituted of:

1. Regularly appropriated State and Federal funds

2. Scientists on State line item appointments

3. Twenty percent of all funds appropriated by counties and the State for the specific purpose of accelerating the survey program in certain counties. The remaining 80% of these funds go to SCS.

Collectively, with these resources, we operate a specialized laboratory program for soil characterization, employ laboratory technicians, and have three soil scientists specifically assigned to soil morphology, genesis, and survey; these faculty also spend a portion of their time in instructional programs. The combined resources also provide us with supplies, equipment, and travel funds. With these inputs and the fine cooperation extended to us by the SCS personnel, we presently have the best working team that has been developed since the Legislature passed the enabling legislation in 1941.

Now, what are our goals? The primary goal is to promote a cooperative survey program with SCS that will insure the citizens of Florida that all concerned with land-use will have adequate surveys and resource data to make wise decisions on its allocation and use and to complete the survey in the shortest possible time. In order to accomplish this goal, we must develop a program that will not only meet the traditional and modern needs of an agricultural enterprise that rivals its counterpart in every other state in the Union, but also the needs of people and agencies associated with health, transportation, tax assessment, land-use planning, parks and recreational areas, urban and industrial construction, and many- other endeavors too numerous to mention or perhaps not yet a reality.

We are making every effort to produce physical, chemical, and mineralogical research data that will enable all those using the soil to make proper decisions. These data include:

1. A full description of the external and internal features of the major soils as exposed in recent road cuts or freshly excavated pits.

2. A textural classification based on particle size, distribution of the sand, silt, and clay in each horizon giving rise to such classes as sand, sandy loam, loam, etc.
3. Plasticity, liquid limit, permeability, and corrosivity of the major horizons.
4. Available water, soil reaction, extractable nutrients, organic matter content, exchange capacity.
5. Mineralogy. The kinds and relative amounts of minerals (for example, kaolinite, vermiculite, montomorillonite, etc.) that each soil contains.

The generation of research information and excellent maps is of little value in the archives of libraries and the files of technologists and scientists around the nation. To be of value, it must be used and, perhaps as important, made useable. As many of you know, the Agricultural Experiment Stations are generally a part of a larger University Division--in our case, the Institute of Food and Agricultural Sciences which is often referred to as IFAS. IFAS also formally trains soil scientists and other land-users in the College of Agriculture and School of Forestry, Natural Resources and Conservation, and generally extends knowledge and training to the people of the State through the Cooperative Extension Service. Teaching, research, and extension functions are brought together at the Department level. Another goal or role for Soil Science Departments, therefore, is to train young men and women in the area of soil survey, soil characterization, and good land-use programs applicable to the needs of society. It is our goal to extract soils data from the "archives", the soil survey reports, etc. and transmit it in understandable terms to the formal student at the university and the informal student in the city and on the farm. An example of informal training is the workshops we have conducted for land appraisers, tax assessors, and county agents on the use of soil survey information in their endeavors. The formal training is provided by our University courses in classification, morphology, genesis and soil survey. We also have a research function in pedology that, many times, is initiated to answer questions originating from the soil survey and characterization data. The research, by faculty and graduate students, is designed to provide additional information on the geomorphology, genesis, classification and survey of our soils. The research is also a part of the larger body of information necessary for making wise land-use decisions.

The role of the University at-large, that is of all Universities, is to take the larger body of information and put it to use nationally and world-wide. It will require several generations of publications at all levels of understanding many research projects and perhaps some additional surveys to capitalize fully on the value of our No. 1 resource -- the Soil.

The goals of the Agricultural Experiment Stations or the University, if you will, in the Cooperative Soil Survey Program are, therefore, a part of broader goals: In summary, they are:

1. To cooperate not compete with SCS in surveying and characterizing the soils of every county as soon as possible.
2. To train scientists and technologists in soil science and proper land-use.
3. To conduct research necessary to elucidate questions arising from the survey.
4. To collect, interpret, and disseminate understandable information on soils and land-use to the citizens of every state.

It will take a real team effort to accomplish these goals but I am confident the SCS - University - Other Agency teams will succeed in this mission.

SOIL SURVEY IN BELGIUM

Rene J. Tavernier

First of all I wish to thank Mr. W. M. Johnson for the invitation to participate in this Work Planning Conference of the National Cooperative Soil Survey. I have had the privilege of attending several previous Conferences during the past 30 years, so I have been eagerly looking forward to this one. It is not only a good way to gather valuable information but also a fine opportunity for seeing old friends again, for renewing acquaintances and for making new friends.

The Soil Survey in Belgium

Although the study of land resources in Belgium started in the first part of the previous century, the systematic survey of the country only started in 1947. The mapping in the field is carried out at the scale 1:5000, while the maps are published at 1:20,000. Presently about 95 percent of the country has been mapped and the remainder should be finished within three years. Approximately 75 percent of the sheets have been published and it is planned to finish the printing before 1983. The most important activities of the Soil Survey work is oriented toward Soil Survey Interpretation. This work is carried out in co-operation with the Soil Institutes of the Universities, with the Experiment Stations of the Ministry of Agriculture, and with the Research Centers of the Ministry of Public Works.

Soil Survey investigations still are an important part of the research in Belgium. They are not only related to soil genesis and classification, but also to the interactions of various kinds of soils and potential polluents such as fertilizers and pesticides.

The study of soils in tropical and intertropical regions, which is already an old tradition of Soil Science in Belgium continues to form an important part of the Belgian Overseas Aid Programme, not only in Zaire, Ruanda and Burundi, but also in many other countries such as Cameroun, Ivory Coast, Indonesia, Mayaysia, Peru and several countries with mediterranean climates. This work has been facilitated by the creation in 1961 of an International Center for post-graduate Soil Scientists at the University of Ghent, where every year about 25 young soil scientists, mainly from developing countries receive advanced training.

Soil Survey activities in Belgium have been strongly influenced by the USDA Soil Survey. Several of our present and former staff members have been trained in the United States and we are much indebted to many soil scientists of your country, amongst others to Dr. Charles E. Kellogg and Dr. Guy D. Smith. As early as 1949 Dr. Kellogg published "An explanatory study of Soil Groups in the Belgian Congo". This publication has been very, stimulating for all Belgian Soil Scientists working in tropical areas. Since 1950, the Belgian Soil Survey had the privilege of Co-operating with the USDA Soil Survey--particularly with Dr. Guy D. Smith--on the preparation of a new system of Soil Classification, which has now been published. We all have learned a great deal during the series of meetings, both in the U.S. and in Belgium at which the various approximations were discussed.

Thanks again for extending an invitation to participate in this conference.

SOIL RESOURCE INVESTIGATIONS IN CANADA .

John A. Shields
Canada Department of Agriculture
Ottawa, Ontario

I must first take the opportunity to thank you for the invitation to participate in this work planning meeting. I assure you that my colleague, Dr. Cliff Acton and myself are very pleased to be here. Dr. Acton is Senior Pedologist and correlator for the Ontario soil survey. We also bring warm greeting from your friends John Day and John Nowland to the sunny north who attended your last meeting.

SOIL CLASSIFICATION: The System of Soil Classification for Canada (Canada Department of Agriculture, 1970) has been updated as amended in 1972 and published as a revision in 1974 (Canada Dept. of Agriculture, 1974-Revised). Revisions included in the present volume are based on changes in the system agreed upon at the 1973 and 1976 meetings of the Canada Soil Survey Committee (CSSC) and on decisions of the Sub-committee on Soil Classification. This revision as prepared by the Classification Subcommittee of the Canada Soil Survey Committee under the capable (and somewhat persistent) chairmanship of Dr. J.A. McKeague has maintained greater continuity in content and in format and writing style than previous versions synthesized from the efforts of various chairmen responsible for different soil orders.

The major changes introduced in this publication are:

1. Inclusion of a Cryosolic order for soils having permafrost close to the surface.

2. Elimination of subgroup modifiers and hence a major reduction in the number of possible subgroup combinations.

3. Deletion of soil type as a category in rhe system.

4. Increased uniformity of presentation of the soil orders.

5. Amplification of the introductory material to give more of the background and rationale of soil classification in Canada.

This version of the Canadian system reflects the present state of soil taxonomy in Canada. It was influenced by history, by regional biasses, by various concepts of logic, by new information on soils in Canada and elsewhere, and by international concepts of soil. It represents as it should, an approximation of a collective view of Canadian pedologists, but it is not necessarily entirely satisfactory to any one pedologist. It is considered as a stage in the evolution of an improved system that will result from further knowledge of soils and improved ordering of that knowledge.

The material is organized as follows: First, the history and rationale of soil classification in Canada are outlined briefly to point out the changes of concepts with time and the current points of view on soil taxonomy. This is followed by chapters that define soil, soil horizons and other basic terms, and explain how to key out the classification of a soil. A chapter is devoted to each of the 9 soil orders and the great groups and subgroups within each order. The orders are arranged alphabetically but great groups and subgroups are arranged as they were in previous versions of the system. Chapters on the family and series categories and on soil phases follow. The recently developed landform classification system for soil surveys (CSSC, 1976) is included as a separate chapter. The chapters on International Correlation and Terminology for Describing Soils are abbreviated appreciably from previous issues of this publication.

SOIL SURVEY: Active Soil resource programs continued in all provinces. Broad biophysical surveys were conducted in wildland areas, reconnaissance surveys in agricultural areas, detailed surveys around urban areas and detailed biophysical surveys in National Parks. Reconnaissance surveys were also conducted for gas pipeline location in the central Keewatin District of the Northwest Territories and for Department of Indian Affairs in the Yukon and Hay River in the Territories.

Within the provinces, there was increased use of survey information for landuse planning and management. Consequently, emphasis was placed on interpreting the information for non-specialist users and on early release of preliminary information. Surveyors served as environmental advisors on the Sarnia - Montreal pipeline and assisted in assessing its deleterious effects on crop production. In the Cordillera, surveyors advised planners on environmental hazards to coal development and others have advised planners within our National Parks. Surveyors in Ontario, Manitoba and Alberta advised planners on urban development. Reports and recommendations were completed to assist Department of Indian Affairs to formulate a land use policy for the Northwest and Yukon Territories.

Sustained pressure for special project surveys required to provide the information described above coupled with a relatively static man-year resource base has resulted in some reduction of man-years assigned to surveys in southern agricultural areas. Efforts are being continued to catch up on the backlog of unpublished soil maps and reports in these areas.

CanSIS

Development and implementation of the Canadian soil information system (CanSIS) has progressed steadily on two fronts:

a) development of the digitized map, soil cartographic file - data input procedures, data management and derived maps. This was a large undertaking and many problems were encountered. However, in the very recent past many of these have have been overcome making this system now essentially operational. Most programming effort is now spent in debugging, and some additional development will be necessary in the future. This will centre primarily on map editing, data management and streamlining of procedures for producing derived maps.

b) development of data management procedures for the soil data file. There is a major undertaking Involving procedures of data input (tailored to reflect our complex data collection forms), editing and updating, report generation and a catalogue of output routines. We have completed and have as a package the routines for data input and editing, complete with Job Control Language. Also some routine output procedures have been completed. The single major effort remaining is the programming necessary for the report generator, but hopefully this will be finished by July/77. Some debugging will be necessary. It is noteworthy that all "hard" data files will be run on this basic system.

LAND EVALUATION: The last two years have witnessed the conception and development of an Agricultural Land Evaluation Program by the Soil Research Institute in Ottawa. This program was developed with a clear understanding of the importance of agriculture to Canadian and world economics and the need to resolve land "se conflicts between agriculture and other major users of the Canadian land resource. Although the program borrows heavily from recent publication for the basis of procedure, it is moulded somewhat to reflect Canadian needs within the manpower resources available to meet these needs within a reasonable period of time.

Considerable time and effort has been expended by F.A.O.* and others towards the development of an international framework for agricultural land evaluation. This was done with the full realization that questions related to land evaluation can best be answered only in a local context with locally devised evaluation systems; derived from locally available data and presented in the most meaningful manner for local "se. The framework, in fact, provides primarily an outline of the principles and terminologies to be used in the construction of local systems. Central to the framework is the thesis of using

---

* The most significant of these is; Brinkman, R. and A.J. Smyth. 1973. Land Evaluation for rural purposes. Int. Inst. Land Reclam. and Imp., Wageningen, The Netherlands.

economic as well as physical criteria for comparing land suitabilities, on the grounds that any land can be made suitable if costs can be justified.

Within the context of our program, land evaluation is viewed as a procedure or procedures concerned with assessing possibilities in the use of land, with the effects of these on the benefits obtained from land, and with the means through which desirable alternatives can be understood and undesirable ones avoided. Also it is concerned with the possibilities of change in the land itself, particularly where change may result in lowering of land quality.

Principles for the approach to land evaluation problems are based on the assumption that farmland production potential should be determined by considering the land characteristics and economic factors that control yield per unit area. The significance of each contributory factor and of their interrelationships, depends on the exact nature of the land use considered.

Land evaluation concerns itself with the following kinds of questions:

a) what are the qualities of agricultural lands relative to other lands in the nation?

b) what consequences can be foreseen if present land use practices and land ownership patterns remain unchanged?

c) what are the alternate socially and economically relevant uses that are physically possible, and which of these offer possibilities of sustained productivity or services, whithout detriment to the environment?

d) what are the environmental and social benefits or consequences of each alternative land use?

e) what inputs are necessary to optimize the benefits or consequences associated with each use?

Land evaluations may be expressed as either qualitative or quantitative classifications, but the more quantitative classifications will provide more objective and precise measures of alternatives of land use. The precision of quantification depends on the immediate purpose and the general precision of the study, and thus upon the stage in the planning process at which the study is undertaken. Assessments are developed generally within the contexts of particular map units and usually do not take detailed account of such factors as distance to markets, market trends, socio-political trends, etc. Quantitative economic assessments are normally confined to simple development costs in relation to production benefits. Normally these ate just sufficient to provide a reasonably reliable estimate to profitability, often based on parameters which are provisionally chosen and, for the time being, imprecisely defined.

The procedure of land evaluation progresses in stages, each stage being dependent on the availability of quantitative data and on the degrees and kinds of problems being experienced by resource users. Each stage is defined specifically in terms of a series of assumptions, these being of the type that would answer the pertinent land use problems with a minimum of ambiguity and a clear understanding of degree of reliability.

Contemporary requirements of the program focus on better systematization of previous rating schemes and on quantification of categories used in relation to productivity and production potentials. These categories must be correlated with adequately defined and pertinent economic indices reflecting land utilization types and associated capital and recurrent costs. Consequently, during the past year emphasis was placed on collection of background information in preparation for undertaking two pilot areas next year.

It was decided that the program should have several major thrusts in the beginning. Of these the one requiring major effort was in the area of methodology development due primarily to the complexity of the problem coupled with the dangers of importing technologies from other areas. It is intended that the methodology reflect Canadian agricultural, manpower and support capacity. The methodology will be tested in two pilot areas beginning in 1977; one area under intensive land use and urban pressure in Ontario and one with extensive agricultural land use in the Great Plains.

Other major areas requiring development center on the characterization of climate and the relationships between crops and weather, and the development of a typology of farming system. This latter aspect is particularly important as it is the one single interface between economic and land resource data. Coincident with all of the above is the long term need for systematic yield and land management data for all areas of Canada.

REMOTE SENSING: Initial results from using remotely sensed data on rangelands indicate that suitably selected imagery may be useful in providing supplementary data on extent and type of vegetation and soil moisture for use by range management. A hierarchial system of establishing uniform productivity units was developed to provide information of increasing specificity from regional crop conditions on a biomass basis through to evaluating productivity of specific crops on a defined homogeneous land system basis. This was developed using data accumulating over several years from the main Spring Wheat Test Sites.

Imagery (satellite and airborne) and ground data were acquired from test sites in Quebec to evaluate crop identification abilities and to determine spring viability of alfalfa. Background research on spectral properties of a wide range of plants throughout the growing season showed that solar absorption (Fraunhoffer) lines and fluorescence from a laser source may assist in characterization of crop conditions. Potential relationships between active microwave transmission and soil moisture content were also investigated.

THE ISSS CONGRESS: Members of the Canadian Soil Science Society continue to prepare for the International Soil Science Congress to be held in Edmonton June 18-27, 1978. There will be another announcement published in the ISSS bulletin in March. I hope you all will make your arrangements to attend.

Soil tours are planned in various regions of southern Canada and one tour in northern Canada. All tour books are in the last stages of preparation for editing and translation into French only. The final decision on which tours will be conducted must await an evaluation of registrations in August.

STATEMENT ON SOIL SURVEY by O R S T O M FRANCE

P. Segalen[1/]

As a representative of ORSTOM - that is French Overseas Scientific and Technical Authority - my purpose is not to talk about what is done in France itself, but in various countries most of which are located between the Tropics, and where ORSTOM soil scientists have been working, or are presently at work.

The aforesaid authority started to operate immediately after world war II in French speaking African countries, as well as in Madagascar, New Caledonia and various other islands and also Guyana and the West Indies.

Owing to the political changes developing in the world towards the end of the fifties, the status of ORSTOM changed after 1960. The research people of ORSTOM were entitled to work in parts of the tropical and mediterranean areas outside of the French speaking countries. After more than thirty years of work in these parts of the world, I shall try to sum up, in a few words, what has already been done, what is going to be achieved in the near future, and what problems will arise.

Starting in 1945, under the leadership of G. Aubert, the pedological team grew from the initial four to about a hundred, falling back now to a little more than ninety. The first task was to draw up the inventory of the soils of many African countries, Reconnaissance survey at scales varying from 1/200 000 to 1/50 000 was above all performed. Owing to local requests, some large scale maps were also prepared (at the scales of 1/20 000 and more).

At least in the beginning, very little was known about tropical soils. A large number of profiles were examined and discussed. To obtain the necessary analytical data, laboratories were built in several African capital cities, as well as in France, near Paris, where the central laboratories were constructed, to deliver the obligatory physical, chemical and mineralogical information. At the same time, close connections were established with the main universities of the country.

In the meanwhile, it was felt necessary to dispose of a soil classification. After a first draft in 1956 by Aubert and Duchaufour, several others were prepared by Aubert during the following years. During the sixties, the efforts of all the pedologists working either in France or in African countries brought to achievement in 1967, a complete soil classification which could be used as well in temperate as in tropical areas.

1/ ORSTOM, 70-74 Route d'Aulnay, 93140 Bondy, France

By that time, several generalization soil maps had been drawn concerning countries like Senegal, Ivory Coast, Cameroon, Tchad, Congo, Madagascar, at a scale of 1/1 000 000. Some of the legends of these maps were set up with the more ancient classification; the more recent ones with the modern French classification.

ORSTOM soil scientists were also involved in the first draft of the soil map of Africa and of the FAO world maps, especially in Africa and in the Far East (Pacific Islands). These, of course, were prepared with the help of FAO specialists, using the FAO list of soil units.

During the late sixties and early seventies, soil surveys continued in many African countries where ORSTOM teams had been at work for many years. New soil maps were started or continued in such countries as:

- Dahomey (now Republic of Benin) where a complete set of 9 maps covers the whole country at the scale of 1/ 200 000

- Togo: three sheets at the scale of 1/200 000 in the central part of the country

- Cameroon: three sheets cover the upper Benoue valley

- Congo: three sheets concern the area between Brazzaville and the sea

- Republic (now Empire) of Central Africa: many sheets concern the North, West and Central part of the country

- Marocco: the Southwestern part of the country has been surveyed

- Gabon: new sheets have been issued or are under print concerning various parts of the country

- Madagascar and La Reunion: various areas have been surveyed

In the Pacific, a complete survey of the New Hebrides has been performed. The maps are being published now, one by one. A new generalization map has been prepared for New Caledonia.

In America, several maps have been published which concern the coastal area of Guyana. The volcanic parts of Guadalupe and whole Martinique were surveyed in detail (1/20 000). These large scale maps are necessary to prepare land use and capability maps.

But, outside the traditional countries of ORSTOM, pedologists were at work in new areas, such as, Ethiopia, Lebanon, Afghanistan, and in America in Venezuela and Ecuador. In these countries, instead of having teams of its own, ORSTOM participates in the surveys with the local soil teams. Various maps have been achieved in these areas but are not printed yet.

So, for the time being, soil survey is still going on in many countries. It is considered very useful to study soils in the field to find out where end why they developed as they are. In such a way, much knowledge has been gathered on the genesis of the main tropical soils both on those that are frequently encountered such as ferrallitic soils, and on those that are important but occur in limited areas (andosols for example). In some countries, data necessary to the understanding of soils were so scarce that it was found necessary to collect them (for instance, geology, geomorphology, vegetation) along with those of soils (in New Hebrides).

All the information collected on soils has helped to build up and strengthen the classification, which has taken benefit of works on soils of both temperate and tropical regions. As surveys proceed and knowledge on soils grow, some people are of opinion that some change should be made, and even that a new approach should be found for classification. It is necessary to take into account not only the progress on the knowledge, but also on the available techniques.

The results gathered by all these soil surveys have been useful for the development of the different tropical countries; they helped to choose the best zones favorable to agriculture and have usually been followed by much more detailed studies concerning soil management, and especially soil conservation.

Furthermore, new problems have arisen with the legends. Indeed, though one of the aims of the classification is to provide the surveyors with a good legend, it seems more and more difficult to use the classification as it stands now for the representation of the soil units. Soils are related with the landscape in general, and more closely with the slope. We certainly need to associate soils along a slope when they are genetically related and even when they are not. The representation of such related soils sets new problems for which different solutions are now being tried.

At last, a soil map appears to everyone as a very elaborate document using a vocabulary of its own, which certainly sets problems for non initiated technical people. So very often, it appears necessary to express the results of the survey into a more easily understandable language. This is one of the aims of the soil resources map prepared for Upper Volta which is a link between the soil map itself and the technical people.

SOIL SURVEY IN THE NETHERLANDS

G. J. W. Westerveld

Netherlands Soil Survey Institute
Wageningen - P.O.Box 98

The activities of the Netherlands Soil Survey Institute must be seen against the background of geographical and domographical conditions in this country and of the far reaching changes that have taken place in society during the last 25 years.

The Netherlands belong geographically to the northwestern European Plain and are located along the North Sea at the estuaries of the rivers Rhine, Meuse and Schelde. The climate is maritime with moderate temperatures, a rainfall of 750 mm which is evenly spread over the year and a precipitation deficit of 100 - 120 mm in summer.

Fifty percent of the country consists of flat and low lying soils developed in alluvial deposits (aquents and aquepts) and in peat. The remaining part is somewhat more elevated and slightly undulating with sandy (aquods) and loess (udalfs) soils developed in sedimentary deposits and in glacial till. The majority of the soils are hydromorphic with groundwatertables within 1.00 - 1.50 m below surface. They are artificially drained to allow agricultural use.

Population density is high (average 396/km^2) particularly in the low lying western part of the country (Amsterdam - The Hague - Rotterdam - Utrecht), the so-called West-Holland conurbation, where half of the population is concentrated on 20% of the total landsurface.

Agriculture is very intensive and uses 80% of the available land. Large amounts of money are spent on rural reconstruction to create greater productivity for agricultural workers. The employment in agriculture has declined from 17% to 6% of the working population in the last 25 years.

Land is scarce and because of the increase in both population and prosperity higher demands are being made on agricultural land for urban and industrial use, for roads, recreation and national parks. Since 1950, 250.000 hectares have been allocated to these purposes, covering 10% of the total area available for agriculture.

These problems have forced the Government to introduce zoning regulations emphasizing concern for the environment in order to maintain a livable country. High priority is given to environmental protection particularly against soil, air and water pollution.

In the fifties the work of the Dutch Soil Survey was mainly directed towards agriculture, including horticulture and forestry, and only in a minor way to non-agricultural areas.

Since 1955 a rapid extension of soil survey applications materialized both in terms of land consolidation and rural reconstruction and in the widely ranging areas of non-agricultural land use.

Particularly in the urban zones a change in land use is usually determined by non-pedological factors and many soils have to be used for purposes for which they have serious limitations. Here, the soil scientist is asked what can be done with such soils to make them suitable, how much will have to be invested and what the results will be.

A part of the surveys and related research in our Institute is done for commissioners, originating from both governmental offices and private enterprises. Every year 50 - 70 projects comprising 50 - 70.000 hectares are carried out, requiring 30% of the manpower in the Institute.

Small scale maps are prepared for nation-wide land use planning purposes and large scale surveys for a wide range of purposes such as: urban development, rural reconstruction, forest management, layout of recreation areas and sport fields, protection of nature, groundwater management, highway and pipe-line construction, developing sources of sand, gravel and clay.

Also a regular soil survey of the entire country was started on a map scale 1:50.000. Up to now about 60% of the country has been mapped. This survey shall be completed within the next ten years requiring 20% of the available manpower.

In order to compare the results of different soil survey methods, a field-study was initiated recently. In the same area different survey methods are tested on varying map scales:

- a free survey method

- a survey method in which the number and the location of the augerhole observations are fixed in a grid-, a random- and a stratified random system

- in these methods the soil-boundaries are delineated both in the field and by a computer.

For all methods, aspects like purity of the delineated areas and reliability of soil boundaries are analysed and compared.

For the need of both regular and commissioned surveys a framework for soil survey interpretations for agricultural and non-agricultural land uses has been developed. Estimates of soil suitability and limitations are based on separate estimates of pertinent and well defined factors for each kind of land use. Such factors are soil attributes that may be inferred from profile characteristics, e.g. drainage status, moisture supply, bearing capacity. Many basic studies remain to be done to complete this framework.

Physical and hydrological soil characteristics are increasingly used in mathematical simulation models. These models are being developed for predicting the moisture distribution as a function of rainfall, evapotranspiration and groundwater movement. At present special studies are made to relate soil structure to different aspects of soil physical behavior.

Aside from this work on soils the Dutch Soil Survey becomes increasingly involved with other aspects of environment.

In cooperation with the National Geological Service a geomorphological survey for the entire country on a map scale 1:50.000 has been initiated and will be completed within 10 - 15 years.

In a nationwide land use plan, prepared by the National Planning Board, agricultural needs are judged against needs for recreation, urbanisation, national parks, etc. Our Institute has provided not only the soil data for this plan and for similar regional ones, but also data on historical aspects of the landscape as reflected by shape and age of parcellation, old roads, buildings, etc. All those data are surveyed and presented in a way that planners can use them.

We are together with other Institutes cooperating in survey projects in which ecological data are surveyed and interpreted for physical planning purposes. A centre for ecological survey is currently being organized in close cooperation with the Netherlands Soil Survey Institute.

As part of an environmental computer information system, a system for the earth sciences has been set up, including:

- input facilities for all data (boarelogs, profile descriptions and maps)

- data base management systems: G-EXEC (NERK-UK) and GRASP (U.S. Geologic Survey)

- a system for automated cartography (Computervision, less elaborate than for USDA, but with the same soft-ware) obtained and developed in close cooperation with Soil Conservation Service (SCS)

- a limited number of application programs.

We are in the process of producing the first maps in the context of a regular production procedure.

Furthermore, preparations are made and sample area surveys are carried out for a systematic survey based on the visual aspects of the landscape. The data will be entered in the Computervision system, and every customer will recieve taylor-made answers on maps, magnetic tapes or in the form of tables.

In terms of outside activities we are actively engaged in the Working Groups of Soil Information Systems and Soil Micromorphology of the ISSS. Furthermore, Staff members of our Institute are asked as experts on soil survey in developing countries (e.g. Kenya, Zambia) and colleagues from abroad participate in training programs at our head-quarters.

Scientific papers of the Netherlands Soil Survey Institute, which seem to be of interest for colleagues abroad, are published in international periodicals or in our own series: "Soil Survey Papers" in the English language.

In 1976 we published a textbook in the dutch language with profile descriptions, laboratory data and characteristics on land use and physiography for 32 major soils in the Netherlands. Each description is illustrated with a color photograph of a soil profile and an oblique black and white aerial photograph of the landscape in which such soils are found. An English version of this book "The Soils of the Netherlands" is under preparation.

The Institute is also involved in the activities of the International Soil Museum, which is accomodated since January 1977 this year in a new building close to our office at Wageningen.

Mister Chairman

Since the establishment of the Netherlands Soil Survey Institute in 1945, there has been a close link with the National Cooperative Soil Survey in the United States of America. We appreciate this contact very much due to the leading position of your country in soil survey and, soil survey interpretation methods.

We bring you the best regards of our Director and our colleagues in Holland. We feel very happy that SCS has given us the opportunity to join this conference, to discuss with colleagues and to learn more from your Soil Survey methods and results. We thank-you very much for this invitation and hope this conference shall be successful for all participants.

Wageningen, January 1977

The International Agricultural Research Institutes and the Use of Soil Survey Research Data

F. R. Moormann, IITA

The International Institutes started in Mexico (CYMMIT) and the Philippines (IRRI) by the Ford and Rockefeller Foundations, have grown since in number and are now funded by the Consultative Group of International Agricultural Research (CGIAR), a loose confederation of donor countries and organizations and the World Bank. The philosophy behind the establishment of a string of institutes in the developing world was and is, to establish high level research and training in those areas, where much research is needed, but is either not available or not sufficiently developed. All institutes have a specific mandate; that of my institute, IITA in IZADAN, Nigeria is "to improve quantity-and quality-wise the foodcrop production in the humid lowland tropics."

The early successes of the initial institutes, and their major contribution to the "Green Revolution" of the sixties is well known and publicized, as is the international recognition in the form of a Nobel prize for Norman Borlough of CIMMYT some years ago.

The orientation of most work of those institutes that work with crops has been strongly towards the plant-side of crop production. Breeding was and is a major concern, as were the supporting activities which were mainly, if not exclusively, in the field of agronomy. With the partial exception of IITA, soils, and more specifically the use of soil survey and land classification data, were and still are not a major topic of research and are not even considered as an important supporting aspect of the work in plant sciences. The "package deal" for improved crop production was and frequently still is considered to be the universally valid approach to improvement of crop production. Only IITA had from the beginning a strong field-soil program where emphasis was given to the variability of soils in relation to crop performance. Though not having a formal soil survey program, the results of such investigation, and the collateral data on climate, landforms, hydrology, etc. have had considerable attention of at least a part of the plant-oriented scientists.

There is a growing acknowledgement now that geographic soils data in the sphere of interest of the Institutes is of extreme importance for the future orientation of applied research work. As an example, I may single out IRRI, where presently the necessity of "local-specific" breeding of rice, and collateral agronomic research is keenly felt, and persued by most of the staff The reasons for this are several, related partially to the personality and background of the principal staff, but even more so to the fact that the original idea of creating plant management packages with high yielding, high input varieties is "running out of steam." Indeed, the green revolution techniques were tremendously successful in those soils areas where land qualities were near perfect, with little or no environmental restraints. These areas form a minority of the rice land, the larger part having a lesser inherent quality and one or more soils, hydrologic, topographic, climatic, or other restraints. Moreover, even in places where there are few environmental restraints, the socio-economic-conditions may be such that one has to be satisfied at least in the foreseeable future with a lower level of technology than that which has been reached by modern temperate zone agriculture. In IRRI, much effort now goes into the development of suitable technology, including the varietal adaption, for these less favorable conditions.

If this trend is to become common, it is obvious that much more use has to be made of the data furnished by soil survey investigations, data which unfortunately are often incomplete or available only in a nonusable form. A requirement is that the field soil capability of the research of the majority of the institutes should be reinforced, but also (where the institutes do not and should not have a soil survey capability of their own) that the soil survey land classification specialists of the world should cater more intensively to the needs of our colleagues in the crop sciences.

1977 Report from North-Central Region, Land Grant Universities

F. C. Westin *

I. North Central Regional Technical Work Planning Conference, Traverse City, Michigan, May 3-7, 1976

Nine committees prepared reports. They are: 1) Rooting Characteristics in Relation to Paralithic Contacts; 2) Improving Soil Survey Techniques; 3) Organic Soils; 4) Water Relations; 5) Soil Potentials; 6) Teaching Soil Science; 7) Correlation and Classification; 8) Soil for Disposal of Waste Products; and 9) Soils on Mine Spoils.

Committee 1, which has no national counterpart, considered objectives dealing with the need to provide soil surveyors with guidelines for uniformly identifying paralithic horizons as well as to study their effect on roots. They recommended that bulk density data be added to Soils-5 forms.

Committee 2, on Improving Soil Survey Techniques, was new for the NC region but corresponds co a national committee. This committee recommended that color IR photos and other imagery be tested, that photos be obtained at the optimum time for soils mapping, and that all-terrain vehicles be employed where appropriate.

Committee 3 on Organic Soils tried to evaluate the Interpretive Guides for organic soils issued 7 February, 1975. They felt another year was needed for testing. However, a number of other points were raised including rating organic soils. A numerical rating system was discussed to evaluate the soils potential as well as its limitations. Other items considered: soil temperature and growing degree days; rooting depth; slope limitations; available water holding capacity; wetness; flooding; development difficulty rating; and forest production.

Committee 4 on Water Relations considered principally the questions "How can soil survey contribute to, and benefit by hydrologic modeling?" The committee felt that soil survey people need to determine where agricultural water is going and what is in the water. The committee listed several courses of action that can be taken including determining the performance characteristics of soils with season and use.

Committee 5 considered Soil Potential and this subject also was covered in a paper delivered to the Workshop by L. J. Bartelli. The committee felt that soil limitations need to be evaluated by taking into consideration the technology available to overcome the limitation. Soil potentials need to be developed for all interpretations pertinent to the soil survey area.

Committee 6 dealt with Improvement of Teaching Methods in Soil Science.

---

* Plant Science Department, South Dakota State University, Brookings, South Dakota 57006

Travel courses and work shops were recommended and also the need was expressed to incorporate soil classification into all soil science curr- iculums. Other suggestions were to identify and establish a mailing list of Extension and Agricultural Experiment Station workers in soil resource and land use planning.

Committee 7 was a combination of committees 2, 4, and 7 of the 1974 N.C.R.W.P.C. The committee was divided on the need to re-define the series control secion although more felt it adequate than not. The committee felt there was little need to standardize phase criteria but that the use and standardization of soil drainage classes needed study. Also it was recommended that as quantitative soils data becomes available for a state that it be circulated to interested neighbor states. Also the group felt that means should be developed to better integrate soil landscape into soil survey work.

Committee 8 dealt with using soil as a treatment medium for waste products. This committee felt more precise definitions are needed, for example, infiltration rate is not constant with time and consequently should be defined more explicitly. Also the committee felt that ratings of soils for waste treatment should be based on soil potential rather than limitation. A majority of the committee objected to rating soils in the mesic and frigid zones no better than moderate. Using potential, this objection is corrected because storage facilities can be utilized. The committee also suggested using slope rather than runoff because it is more easily understood by lay persons. Slope classes recommended are: 0-6%, 6-12%, and over 12% for slight, moderate, and severe limitation.

Committee 9 covered the Classification, Interpretation, and Modification of Soils on Mine Spoils and Disturbed Soils. The national committee requested a response on several points. One dealt with the need for a new suborder of Spolents. The committee recommends further study but most members felt that mine spoils and disturbed soils can adequately be handled with the present classification system.

R. B. Grossman in a meeting with the federal group reminded everyone that in the next 10 years the standard soil survey of the U.S. will be largely completed. As Land Grant University soil survey practionerc we need to concern ourselves with changes this will make in our teaching and research programs. North Central Committees 4, 5, 6, 8, and 9 are especially concerned with the implications of this change in emphasis.

II. NCR-3 and NC-109

The technical research committee concerned with soil survey in the North Central Region is NCR-3. A funded research project - NC-109 began in 1972 was approved through 1976. It has been renewed until September 30, 1981. The name for the new NC-109 project is "Relating Soil and Landscape Characteristics to Land Use." A combined report for NCR-3 and NC-109 follows:

Each state in the region is cooperating to develop a rating system for the soils of the NC Region (using the map from the publication NC-76) based on yielding ability of the soils for corn, wheat, grass and trees. Five of the Agricultural Experiment Stations and the Lincoln S.C.S. Laboratory are participating in laboratory analysis of samples from 10 soils of the region.

Individually, most of the Agricultural Experiment Stations are developing soils landscape guides for agricultural and non-agricultural purposes including tax assessment. Computer soil maps are being tried in several states for tax assessment purposes.

Several states are preparing guides for waste disposal and others are preparing guides for suitability for urban development, reclamation of surface mined areas, application of minimum tillage and distribution of aluminum-sensitive wheat varieties.

Host North-Central states have an accelerated survey effort where state agencies such as Revenue Departments and county boards are helping to finance soil surveys.

Several states also are experimenting with color IR and other special kinds of imagery to improve mapping progress without a loss of quality. Remote sensing is being evaluated in several states.

The North Central states generally have few problems applying Soil Taxonomy (an exception is that it has been troublesome in some areas of Spodosols and Mollisols and that there seems to be no way to get any application above the series category operational).

III. Summary

I felt that one theme dominanted soil survey activities in the North Central Region this past year - the need to plan for the day when the detailed soil surveys of the U.S. will be completed. This event will require a change in emphasis. This was expressed in the consideration given in NC committees to soil potentials, rather than limitations. One committee dealt specifically with soil potentials and it was mentioned in the committees on organic soils, water relations, and the use of soils for disposal of wastes.

The need to look ahead was also noted in the deliberations of the NC committee for improvement of teaching methods. It also is a force operating in the activity of soil surveyors to organize professionally.

The NCR-3 and NC-109 committes are shifting major emphasis to interpretations of soil surveys as is evidenced by the name of our new project "Relating Soil and Landscape Characteristics to Land Use."

Northeast Regional Soil Survey Work Planning Conference Report
to the
Work Planning Conference of the National Cooperative Soil
Survey, January 30- February 4. 1977

by
R. M. Smith
Nest Virginia University

The January 1976 NECSS conference fulfilled its purpose of bringing together appropriate people for discussion of technical and scientific questions and for exchange, dissemination or transmittal of ideas and information to interested individuals or groups including the National Cooperative Soil Survey Conference. Seventy-three representatives were registered.

Individuals present other then permanent (or alternate) State. Caribbean and Federal members and administrative advisors included invited participants from a State Soil and Water Conservation Commission: the Cooperative Extension Service; State Soil Characterization Laboratories; U.S. National Perk Service; U.S. Plant, Soil and Nutrition Laboratory; and a State Dept. of Environments1 Resources.

Some highlights of committee reports.

1. Legal aspects of the use and interpretation of soil surveys.

   This committee did not hold formal meetings, but considerable interest was evident in furthering the professional status of soil scientists by organized societies and licensing as provided by different state laws.

2. Use of soils for waste disposal.

   Chemical and physical properties of wastes and of soils must be considered and combinations recommended that (a) increase agricultural production and (b) avoid harmful pollution of soils, water and growing plants.

3. Inventory and use of forest soils.

   Problems persist, involving mapping scale or intensity. levels of classification. and interpreting manageable landscape units. Foresters, geologists and soil scientists may need to consider more of these problems jointly under field conditions.

4. Soil survey interpretations.

   The development and use of soil potentials requires closer field observations end more data representing local conditions and realistic alternatives.

5. Soil Moisture regime.

It was recommended that water table studies should be conducted in the Northeast, especially to characterize perched water tables and lateral flow on slopes and their significance to soil survey interpretations.

6. Soils reflecting a high degree of physical disturbance by man.

Highly disturbed soils are recognized as economically important. One million acres now occur in the northeast and about 45,000 acres are being disturbed annually. State laws and regulations have been updated. Since modern definition includes all soils made by man, it follows that appropriate mapping units should subdivide this increasingly important acreage into segments of landscape appropriate for pedogenic. treatment and management studies. The conference voted to endorse the WV proposal as amended, involving a new suborder of Spolents and mapping units defined at the family level (including phases of families).

Significant acreages of intensely used urban soils and land fills have been studied, mapped and interpreted in the Washington metropolitan area through cooperation of the Maryland U. Agr. Exper.Sta., the National Park service , and the Soil Conservation Service and others.

7. Evaluating mapping units.

More studies are needed to determine the composition. and to improve and update the accuracy of mapping units and their interpretations. Better field notes, use of the transect method and thoughtful mapping unit descriptions in published reports should be emphasized.

8. Histosols and tidal marsh soils.

Legislation in eight northeastern states identifies tidal marshes as land under or contiguous to tidal waters that support one or more salt marsh species. Greater emphasis on tidal marsh will be required as population and pollution pressures intensify. Current investigations were summarized and encouraged.

9. Soil survey research needs and priorities

The National Survey Laboratory at Lincoln assures the northeast of continued support and assistance. The soil survey input program will identify sources and kinds of available laboratory data but requires inputs from experiment stations and others. Soil morphological changes noted following waste disposal should aid predicting reasonable waste loading rates. Soil interpretations must keep pace with changing technology, new soil uses and research results from all sources,

10. Remote sensing in soil survey.

A regional coordinator for remote sensing, to be located at the TSC, was recommended. A bibliography of remote sensing research has been assembled and is available.

The Executive Committee of the Northeast considers that these 10 committee reports including discussions constitute the heart of the Conference.

In addition to the working sessions there were several informal sessions about special activities of some members end guests.

Representatives of the State Agricultural Experiment Stations reported on activities related closely to soil survey.

Horace Smith, SCS, Maryland, reported on the soil survey of the District of Columbia.

John Foss, Maryland, reported on tephra and soil formation in Northwestern U.S.

Gerald Orson, New York, reported on Maya Hounds in Honduras.

Roger Case, SCS, New York, reported on soil interpretations for the Eastern Ontario Commission.

Vim van Eck reported on West Virginia's activities in East Africa.

Dick Arnold, New York, reported on a climo-sequence of soils in Nigeria.

A special discussion led by John Rourke considered a number of aspects of the revised Soil Survey Manual.

J.C. Patterson, U.S. National Park Service, discussed the importance to the Park Service of properties of some highly disturbed or man made soils.

The next meeting is scheduled for July 18-22, 1978, at the University of Connecticut (Storrs, Connecticut).

REPORT OF THE LAND GRANT COLLEGE REPRESENTATIVE OF THE SOUTHERN REGION

H. F. Perkins*

The biennial meeting of the Southern Regional Technical Work-Planning Conference was held in Jackson, Mississippi, April 5-8, 1976, with Mr. R. C. Carter, Chairman (USDA-SCS) and Dr. D. E. Pettry, Vice-Chairman (Mississippi state University). Fifty two individuals participated in the conference representating twelve Landgrant Colleges and Experiment Stations, the Soil Conservation Service, the Tennessee Valley Authority, the U.S. Forest Service and the Agricultural Research Service.

The members welcomed the participation of the following invited speakers:

Mr. Doug Shanks? City Commissioner of Jackson, Miss.

Mr. W. L. Heard, State Conservationist SCS, Jackson, Miss.

Dr. W. K. Porter, Jr., Associate Director, Mississippi Agricultural and Forestry Experiment Station, Mississippi State University.

Dr. K. L. Anderson, Leader, Extension Agronomy Department, Mississippi State University.

Dr. R. H. Griffin, NASA, Bay St. Louis, Miss.

Mr. V. J. Cissna, Jr., Special Projects Officer, Southern Mississippi Planning and Development District, Gulfport, Mississippi.

Mr. R. I. Dideriksen, Director, Land Inventory and Monitoring Division. SCS, Washington, D.C.

The conference was organized into seven subject matter committees. Although much work was accomplished by each of these predetermined committees prior to the conference, the chairman of each committee rotated to each of four discussion

*Department of Agronomy, University of Georgia, Athens, GA 30602.

groups to give each conferee an opportunity to participate in the proceedings and make contributions to the final report. The following subject matter committees were active:'

1. Histosols and soils of tidal areas.
2. Waste disposal on land.
3. Soil potential ratings.
4. Kinds of soil maps.
5. Improving soil survey field procedures.
6. Soil yield potentials.
7. Major land resource areas.

Since each committee presented a report which was published and is available to members of this conference, I will not present a summary of each committee report. Instead, I will report on some of the highlights of the meeting and other items which may be of interest.

During the 1976 Southern Regional Conference there was perhaps more emphasis placed on interpretation of soil properties for multipurpose land use than at any preceeding conference. Dr. Porter (MSU) stressed that an understanding of soils is basic to agricultural research. We recognize that current agronomic research is becoming increasingly complex and often requires interdisciplinary efforts to solve pertinent problems. The demand for interpretation of soil survey information for non-farm uses is becoming increasingly important throughout the region. Engineers, hydrologists, land use planning firms, sanitarians and consulting agencies are seeking information which is often unavailable. There is a rapid move being made in some areas of the region to use land for treatment of waste water from sewage treatment plants, agricultural processing wastes and industrial wastes. Consulting engineers are frequently critical of sail scientists for failing to adequately characterize and evaluate properties of soils below those necessary for placement in soil taxonomy inferring that the soil scientists are more interested in classification than interpretation.

There is great need for cooperation of research workers in all areas of soil science in the development of interpretative tables and other information for soils and land use. Emphasis should be placed on a positive approach such as soil potential rather than limitations. Interpretative soils information must be simplified to obtain maximum use. Will the ADP programs developed for the National Cooperative Soil Survey aid in generating land use maps that can be effectively used by a land use planning specialist that has not had a" introductory course in soil science? Will automatic data processing, computer map making, remote sensing, standardized tables, standardized write-ups and standardization of programs in general increase user acceptance and understanding of soil survey information? Or, will it prevent the person nearest the soil from becoming a thinker and interpreter of soils information? I can't answer these questions but I think we should constantly evaluate our effectiveness in supplying soils information to an environmentally conscious public.

The need for accelerated soil survey and publication of reports of soil survey for land use planning was emphasized. It is thought by some soil scientists and users of soil survey maps that soil survey should reevaluate the detail of soil survey, particularly in suburban and potential suburban areas. Dr. Anderson speaking on the role of the Extension Service in soil survey pointed out the importance of introducing published soil survey reports to the public and the need to educate local officials on the uses of soil survey reports. An educational program should not be the responsibility of one agency alone.

Contributions of the Land Grant Institutions' in the Southern Region to the Cooperative Soil Survey Program were discussed. In general the states' activiti[es] have been increased for the region, however, anticipated appropriations in some states has been less than expected which has restricted some programs.

A committee has been appointed to prepare an article for possible publication in the Crops and Soils Journal. The article would deal primarily with the relationship of southern soils and crop production.

The changing background of the college graduate may have far reaching effects on the soil survey program. A recent survey indicates that there is a steady decline in college graduates in soil science that have farm backgrounds. There is also a marked increase in female students of soil science. During the past two years the demand for soil science graduates has exceeded the supply. In many areas, agencies conducting soil survey have been unable to attract the best students due to industry and private sectors which offer higher salaries and other incentives. The demand for people with advanced degrees also has resulted in many of the better qualified candidates continuing in graduate school.

Report of the Land Grant
University Representative
of the
Western Region

R. D. Heil
Department of Agronomy,
Colorado State University

This report will deviate from a normal report of summarizing the 1976 Western Regional Work Planning Conference since these reports are already available. Rather, I would like to spend a short time reviewing for you some of the research activities that are on-going at various universities in the western region, and particularly, those research activities that are of direct interest to the National Cooperative Soil Survey.

In the past five years, researchers representing most of the Land Grant Universities found in the western region have participated in a Regional Research Project entitled "Soil Interpretationsand Socio-Economic Criteria for Land Use Planning".

The objectives of this project were:

1) To evaluate the impact of urban encroachment on rural lands.
2) Identify and organize soil data and interpretations needed for present and potential clientele.
3) Evaluate the adequacy of present data and development of new data, interpretations and procedures for overcoming soil limitations.

Some of the research activities under Objective 1 include case studies in California under which land use changes are being documented; effects of water transfer from irrigation to cities have been documented in Colorado; impacts of the Big Sky Recreation Development were studied in Montana; soil cualities of the Willamette Valley in Oregon were mapped and the information was placed into a computerized system for storage and anaylsis for the purpose of determining relationships of land use to soils with different inherent capabilities; Hawaii investigated the performance of their state'sagricultural dedication law. Research in New Mexico has treated the question of "Effects of land use controls on land values in rural-urban fringe areas." A manuscript "as prepared on modeling land use problems in Arizona. A number of other studies were also conducted under this objective. The foregoing are pointed out in order to provide a background pertaining to the nature of research activities.

Under Objective 2, a number of states have developed state soil maps and accompanying interpretations. An Arizona publication provides information that relates soils to climatic and geologic information. Land use suitability maps have been produced using a composite of natural resource maps and ratings developed by planners and scientists.

Colorado is in the process of publishing a "Land Capability Data Base" for all counties. Montana has developed a computer graphic system for generating land resource maps associated with their state soil map. Hawaii has developed a system for rating soils (soil potential) for several agricultural and urban uses.

Under Objective 3, California has compiled substantial soil loss data for a number of California soils. In Colorado, basic field and laboratory studies have been completed on 36 soils representative of proposed coal and oil shale development areas. . Colorado is also evaluating the reliability, credibility and usability of three engineering interpretations of the National Cooperative Soil Survey using the "Delphi" questionnaire technique. Hawaii has developed criteria to compute indices of soil potential. In Nevada, soil temperature regime data have been collected for producing a state map (1:750,000 scale). Soil moisture regimes are being tested in relation to the distribution and productivity of natural vegetation. Oregon has completed extensive studies on septic tank drain-field performance. Montana, in studies of soils potential, has shown that data on soil micro-climates are needed.

This is a very brief review of the nature and scope of some of the research activities being carried out by Agricultural Experiment Stations and Universities in the western region.

Information relative to the progress and accomplishments of this research program are available through the Cooperative State Research Program of the U.S. Department of Agriculture in Washington, D.C.

I appreciate this opportunity to acquaint you with the kinds of research activities that are presently on-going or that have been completed in the western region. Many of these research activities have been carried out in close cooperation and with the help of Soil Conservation Service Personnel. This cooperation and active participation has been greatly appreciated. We hope that the results of this research will help strengthen the Cooperative Soil Survey Program.

Soil and Water Problems of Mutual Interest[1/]

Carl W. Carlson[2/]

I am pleased to have the opportunity to meet and share ideas with the soil survey group. Those of us old enough to remember know something was lost when the soil research now in ARS was split from soil survey in the early 1950's. This split led to a communication gap which, over time, has resulted in a language barrier.

My close association with the SCS soil survey laboratories when I was at Mandan and later at Beltsville has made me aware of the wealth of data that these laboratories have obtained. The management of these laboratories was the best. Therefore, one has a lot of confidence in the data.

Anyone who has had much experience with field research is well aware of the value of a good soil survey. The nature of many of our field experiments are such that a conventional soil survey is adequate. However, many of us found out the hard way that a conventional soils map is not detailed enough for some field research. Unless the soils factors responsible for the response or the lack of response of the various treatments included in the experiment can be identified, one is at a loss to interpret the data or use it to make recommendations to other sites. The soils maps and accompanying taxonomy become the common denominator for communicating the research results.

Our Administrator is asking for a new emphasis on the use of soil maps, soil taxonomy, and soil characterization in planning, initiating, and interpreting our research studies. He is asking that this include all field research, including pest control.. We need your help to meet this request.

Man's improvements in computers have made it possible to process and analyze large volumes of data. This tool has made modeling a way of life. Some of the early models in ARS were developed to predict and route water movement in and over watersheds. The ACTMO (Agricultural Chemical Transport Model)

1/ Presentation at Soil Survey (SCS) Meeting, 'Orlando, Florida, Jan. 30-Feb. 4 '77

2/ Assistant Administrator, ARS-USDA, Washington, D.C.

and the USDA Hydrograph Laboratory models are examples. These models could not have been developed without the data made available by the SCS soil surveys and the supporting laboratory data. In spite of the large amount of available data, we frequently find that the geomorphological data are inadequate. In addition, the spatial detail is not sufficient to predict, with any degree of accuracy, how the watershed delivers water. Such details as the geology and the identification of the land characteristics which account for the shape and the present land use of the watershed are required to make a reliable prediction. The Map Information Assembly and Display System WADS), developed by Bob Birdwell in Oklahoma, provides the detailed data we need for many of our studies. This system, which provides the land use and soil characteristics on a 40-acre grid throughout the State, has sufficient detail to be most useful in our modeling efforts.

The data on the water retention and transmission characteristics provided by the soil survey laboratories are sufficient for our needs. However, the detailed water flow information required to meet the Section 208 of the P.L. 92-500 needs require that we have a much better knowledge of water behavior than we now have.

The greatest need is for better infiltration and hydraulic conductivity data. The problem of obtaining reliable field infiltration data is most difficult. Heated arguments have frequently ensued over which method yielded the best information. Many of us are aware of the difficulty the USDA Hydrograph Laboratory had in their attempts to make field measurements. The importance of the surface layers in these studies has become very evident.

The grain shortages experienced internationally two years ago have shown the need for a better yield prediction capability. Last year, ARS initiated a research program concerned with improving these capabilities. If we can obtain the precision in our watershed models that we are attempting to achieve, we can provide the data needed for predicting crop yields. The degree of precision with which we can predict crop yields will depend, in part, on how well we can describe the effective rooting and moisture extraction patterns of the important crops. Better estimates of moisture flux in the profile will also be needed to understand the soil water relationships.

The objective of a cooperative agreement signed by ARS and SCS last year was to improve the capability of the SCS to predict where and when wind erosion night occur. The model that will eventually be used to make these predictions will require some of the same soil and water data that is required in the crop prediction and watershed models.

The large interest in utilizing agricultural residues as an energy source has raised a question about the needs for those residues to protect our soil and water resources. Currently, ARS scientists at St. Paul, Minnesota, are developing a model to make these estimates. The cooperation of the SCS on this project has been excellent.

What about the future?

The environmental guidelines developed to comply with the water and air pollution legislation passed by recent sessions of Congress will restrict our future farming methods. In addition, energy and ground water shortages will make these inputs expensive and scarce. When the present and future world food needs are considered, it is safe to predict that the American farmer will be called upon to produce more food and fiber.

The only way that these restrictions and goals will be met will be through better land use. In making these decisions, the American people will be expecting some alternatives. These alternatives can only come if we proceed with our modeling efforts in a very aggressive way. From these models, alternatives for growing our food and fiber should become evident.

I doubt that the public will tolerate some of the mistakes made in the government programs in the past. For example, we cannot afford to support a fallow-crop rotation farming system in areas like the wheat-producing areas of Montana and the Dakotas. These practices have resulted in the "saline seeps" common to that area. Nor will the public accept the plowing of fragile wheat-producing areas of eastern Colorado. After drought periods, our government has provided funds for subsidizing the revegation of these lands on at least two occasions.

If we are to meet these challenges, there will have to be better coordination and closer cooperation between ARS and SCS and the other agencies with resource conservation responsibilities. If we can accept the challenge, it is time that we get on with our responsibilities.

Areas where emphasis is needed:

Infiltration. The SCS and ARS have cooperated in making infiltration measurements in the past. These efforts have yielded data which have been used to develop guides and models. Neither Agency is satisfied with the progress made to date. Perhaps part of the problem may be that neither Agency has ever decided what degree of precision would be acceptable or the number of soils that should be included. In spite of past mistakes, we need to continue our search for an acceptable method for measuring infiltration.

Soil structure. On several occasions, scientists from the two Agencies have participated in soil structure workshops and field trips in an attempt to identify areas of mutual opportunity. The last effort in this area that I know of was Dr. W. E. Larson's and Dr. Grossman's field trip into the Northern Great Plains two years ago. At that time, Dr. Grossman requested that ARS bring their soil structure theories to the field. From this, he hoped to obtain a simple quantitative method for measuring soil structure in the field and in the laboratory. To my knowledge, this request was never met.

Method to physically describe watersheds. The problem of spatially describing the landscape continues to be responsible in part for the unreliable predictions of watershed behavior. Our skills in this area could be enhanced if personnel from the two Agencies would cooperate on the project. The capabilities in the field and laboratories in the two Agencies are adequate to undertake this task.

Model for predicting antecedent soil moisture. Our accuracy for predicting the behavior of watersheds, crop yields, and areas susceptible to wind erosion is reduced because of no or inadequate methods for predicting antecedent soil moisture. The field and laboratory expertise in the two Agencies is adequate to make inroads on this difficult problem. The SCS has field people in most counties in the United States. The ARS has a great number of field and laboratory studies where these data are being obtained every week. With good soil survey data, we should be able to predict the potential yields for many soils.

Interpretation of research data. ARS has a lot of data on waste disposal, pest management, and nonpoint sources of pollution that have not been related to soils data. We need to put more emphasis on these interpretations in the future.

Irrigation and drainage. The decreasing supplies of surface and ground water and the increased costs of energy will require better irrigation system design in the future. The degree of improvement that can be made depends largely on the availabilaity of soil intake rate and hydraulic conductivity data. These data are also needed for improving our drainage theories and for the design of drains.

Salinity. ARS has recently undertaken the evaluation of a new water management theory for salinity control in large field experiments in Colorado and Arizona. From these studies, we hope that we can relate the response, or lack of response, to soil properties. SCS is cooperating on these Arizona study.

Mechanisms for accomplishing these cooperative projects:

1. In the past, one or two SCS scientists have had short-term assignments at ARS locations to work on problems of mutual interest. ARS also has had scientists on short assignments with SCS units. These assignments have been very successful. There is no substitute for "eyeball-to-eyeball" discussion of problems of mutual concern. Therefore, I recommend that both Agencies continue to support these exchanges in the future.

2. Because of the need for better infiltration data by both Agencies, the field measurements undertaken two years ago should be pursued with added effort. Each Agency should internally decide the degree of accuracy that would be acceptable in order that its objectives and goals can be set. I understand a workshop is planned in 1977 to work out the details of the cooperative effort.

3. Both Agencies have a real interest in a field and laboratory method for quantitatively measuring soil structure. A joint task force should be appointed to outline a cooperative program on this important problem.

4. ARS needs a soil map for every field experimental site. We are in the process of determining how many sites are in need of such a survey. For some experiments. we also need a soil characterization. After we have this information, we will have our Administrator relay this need to Mr. R. M. Davis.

5. We need to undertake a joint effort with SCS to determine how soil properties and climate relate to food and fiber production. Here too, we need a joint task force to determine what effort is required by each Agency and how the effort best can be coordinated.

Summary

Soil maps, soil taxonomy, and characterization data are needed for most field experiment sites. If research results can be related to soil properties, the impact of the research on land resource areas can be determined. The modeling capability in the two Agencies makes it possible to predict how our land resource areas will respond to man's activities. The field and laboratory capability in the two Agencies should provide most of the resource data needed to obtain maximum food and fiber yields without doing undue damage to our soil and water resources. How well these needs are met will depend on how effective the scientists in the two Agencies can work together.

Soil Survey Educational Programs Make for Effective Use”

by

Harold I. Owens
Agronomist and Soil Conservationist
Extension Service-USDA

Members and guests of the soil survey work planning conference, it is indeed a pleasure to meet with you. Working with the educational aspects of the National Cooperative Soil Survey is a very rewarding activity. The Cooperative Extension Service, in cooperation with the Soil Conservation Service, the experiment stations, and other agencies and institutions, plan and conduct educational and informational programs to encourage and stimulate more effective use of soil survey information and data.

The cooperative effort in planning and conducting educational and informational programs related to the use of soil surveys is found at the national, state, and county levels. A coordinated effort is carried on between the SCS and the Extension Service, USDA, in Washington to notify our respective counterparts in the states of the status of soil surveys and the impending publications of new soil surveys. In the Extension Service we look to the stote Extension specialist in agronomy, soil science, soils, and/or soil conservation to take the lead in working with the SCS and the experiment station on educational and informational programs and activities. Educational programs and activities related to the use of soil surveys varies. In order to give you a brief report I would like to present a summary of some of the educational programs as reported by the state Extension specialists.

In Florida, the educational effort is focused on workshops for farm managers, rural appraisers, vo-ag teachers, county Extension agents and participants in the cooperative research in forest fertilization programs. The goal of the workshops is to train the participants to assist local clientele in using the detailed soil surveys as they are released in the respective counties. Since 1969, ten workshops have been held. A handbook providing the program content of the workshops is used by the staff and participants. The program includes a one-half doy session of illustrated presentations on seven topics. This is followed by a one-half day tour to observe selected soil series and an open book test.

In Florida, to supplement the workshops three fact sheets on soil survey data and information is planned for release by July 1977.

In New Jersey, we find that soil surveys have been and are continuing to play a major role in land use programs. The cooperative educational-informational program has been developed and presented throughout the state on the use of soil survey maps and data. Cooperating are the Cooperative Extension Service, Soil Conservation Service, and the State Department of Agriculture in planning and conducting one-day or evening short courses for different users of soil surveys. Topics include:

1/ Presented at the Work Planning Conference of the National Cooperative Soil Survey, Orlando, Florida, January 31, 1977.

1. Soil survey -- A tool in land use planning.

2. Soil survey -- Its use (example: septic tank disposal systems).

3. Soil survey -- The history and use.

Another use of soil surveys wos made at a number of county meetings held to explain the New Jersey sediment and erosion control law. Soil surveys were explained and how they can be used in sound planning, The Blue Print Commission on the future of New Jersey agriculture made use of soil surveys in locating prime agricultural lands.

Soil surveys are explained at farmers' meetings to show how soil surveys fit into the picture of making more efficient use of the soil testing program or the need and benefit of drainage on farms.

Mony counties hove appropriated funds to speed up the soil survey program after the importance ond need of the accelerated soil survey program was explained to County Boards of Freedholders.

The State of Washington reports they have held five soil survey introductions in the state in the past three years. One of their most successful introductions wos held in King County, the largest county in Washington in terms of population, in March 1975.

A series of events and planning sessions, contacts, and publicity preceeded the final week-long sessions. A followup on the initial program sessions. Tours were held. The SCS has had considerable contact with mony original participants on a one-tosne basis. The original sessions hove lead to a series of four workshops in western Washington counties between Extension, SCS, and the Deportment of Social and Health Services to work with sanitarians, designers, and installers of septic tanks on soil potentials for waste disposal.

They report the key to their success with the soil survey introduction were:

1. An early start six months in advance of the soil survey introduction.

2. Identifying specific audiences and planning the educational sessions with them in order to give them what they want.

3. Having a local contact to keep in close touch with the audiences identified and interested.

4. The excellent cooperation between the SCS and Extension.

5. Not overselling the product, that is, making sure the surveys limitations were understood.

A cooperative educational-informotiohal program is conducted in Iowa involving the Cooperative Extension Service, the Soil Conservation Service, and the Agricultural and Home Economics Experiment Station. The educational program starts before the field work is started. It is also conducted during and after the field work is completed and continues beyond the time when the final published report is distributed. The report from Iowa for the year July I, 1975, to June 30, 1976, shows the following: pre-field work information meetings were held in five counties. First acre ceremonies were held in four counties. Last acre ceremonies were held in five counties. Advance report meetings were held in two counties and the published report was explained in seven counties. You may be interested in the attendance that Iowa reports. For example, attendance at the soil survey report distribution meetings in Howard County was 430 people attending 9 meetings. The attendance per meeting varied from 28 people to 93 people. In Linn County, 9 meetings were held with 319 attendees. The attendance varied from 19 to 73. In Webster County, 12 meetings were held with 796 people in attendance varying from 38 to 110 ot each meeting. In addition, they conduct training programs for county Extension directors and district conservationists, sanitarians, realtors, boards of supervisors, county engineers, county assessors, and rural development committees. They also publish special publications to supplement the soil survey reports including a bulletin on soil judging. Special publications that ore planned include a handbook for country sanitarians, Extension, SCS, and others; soil survey facts, soil productivity ratings, soil characteristics and herbicide management, and soil resources of Missouri river bottom lands.

From the examples of educational programs conducted in some of the states we can see that the state and county staffs tailor the activities and the techniques used to provide soil survey information to the many different users.

Because of the ropid expanding demand for soils information, Tennessee Cooperative Extension Service, in recent years, has directed special attention to the expansion of its educational programs in the area of soils and soil surveys. The objective of the educational efforts ore to promote broader, more intensive, more effective use of soil surveys and soil information contained in soil survey reports. The initial efforts of the educational progrom were channelled into a relatively comprehensive soils in-service training program for Extension agents. The training program included three separate phases or units:

1. The first unit was centered around basic soils covering the topics of soil formation, basic physical and chemical properties of soils, including texture, structure, soil-water relationships, clay minerology, and basic soil fertility relationships. Visual aids were used to present this material.

2. The second phase included in-the-field training sessions for each county staff. The soils specialist spent two full days in the field in each of the 95 counties training county staffs on the properties of the soils in their counties.

3. The third unit of this training is planned to be conducted in a classroom situation and will emphasize the use of soil survey information, soil interpretations for diferent purposes, and the relationship of soils to soil and crop management decisions and systems.

Another educational activity conducted in Tennessee was to put special educational emphasis into counties in which progressive soil surveys were just getting underway and with counties with newly published soil survey reports. In counties where a progressive soil survey is about to start they organize and conduct county-wide meetings. All the links in the potential user chain (of soil surveys) are invited and encouraged to attend.

In counties in which newly published soil survey reports are about to be released we have a set schedule of educational activities that we follow.

1. News articles are written and radio spots are prepared to design usefulness and publicize the soon-to-be-released soil survey report.

2. Early in this period a two day in-service training workshop is scheduled and conducted for the state agricultural workers in the county. Slide sets are developed prior to the workshop and used as aids in presenting the subject matter. Field work is also conducted during the workshop concentrating on the use of soil maps and the material contained in the (soil *survey)* report. Four or five tracts are selected showing the different soil associations and each tract or site constitutes a complete exercise in the use of the soil survey reports. On the last afternoon of the workshop time is devoted to formulating meetings designted to introduce the report, and how to use it to all the different groups in the user chain.

In Tennessee they feel thot the local agricultural workers who live and work with the people in the county aren't "tooled-up" and prepared to do the job, it won't get done, so they encourage them to carry the ball from this point on. A soils specialist does attend and acts as a resource person and trouble shooter at the meetings conducted by local workers. Tennessee reports excellent results from this approach to educational programs and activities related to soil surveys.

- - - - - - - - -

REPORT PRESENTED TO
NATIONAL SOIL SURVEY CONFERENCE
ORLANDO, FLORIDA
JANUARY 30 - FEBRUARY 4, 1977

Kermit N. Larson
Forest Service USDA

The Forest Service welcomes the opportunity to participate in this conference and report to you on our soil survey activities.

I would first like to acknowledge the recent publication and distribution of Soil Taxonomy by the Soil Survey Staff of the Soil Conservation Service. This publication is a valuable contribution to the field of soil science in the United States. We should not underestimate the difficulties and importance of this achievement. I believe that it is the responsibility of each scientific discipline to develop its own common system of classification and terminology. Many disciplines do not have such a system, particularly one that is useful in mapping and interpretation. Soil Taxonomy fulfills this responsibility, and represents a great advancement in the field of soil science in this country.

For those of you who may not be familiar with the U.S. Forest Service, our activities are grouped into three principal areas. Administering the National Forest System (NFS) is a major responsibility. The NFS includes 187 million acres of Federal land located in 44 States, Puerto Rico, and the Virgin Islands. The NFS is composed of 155 National Forests, 19 National Grasslands, and 19 Land Utilization Projects.

The FS is charged also with providing assistance in the protection and management of the Forest resource outside the NFS. This arm of the FS, called State and Private Forestry (S&PF), works mainly through the various state forestry and natural resource agencies to further scientific land management.

The Forest Service's third "arm" is research, an integral but independent part of the organization devoted to finding new and better ways to develop, manage, protect, and utilize our renewable natural resources.

The Forest Service employed its first soil scientist in 1955. We have been a cooperator in the National Cooperative Soil Survey since that time. This represents over 20 years of active participation in the survey. The agencies' need and demand for soils information has increased dramatically during this time. Our soils staff is still struggling to keep pace with the demand for soils information which seems to increase each year. The soils staff in the National Forest System has grown from 10 in 1956 to 80 in 1966, and to 215 at the end of 1976. This does not include soil scientists in Forest Service Research or State and Private Forestry.

Knowledge of the basic soil resource is essential to all phases of planning and management of National Forest System Lands, and in the forestry related assistance provided through the State and Private Forest Service Programs. Because a substantial amount of the work involved in securing and transmitting knowledge of the soil resource is investigative or of a developmental nature and involves exoansion, testing, and application of research findings, a strong link with forestry and related research, both within and outside the FS, is necessary.

The FS soil management program is a primary contributor to an increased understanding about the science of forest and range soils. It is designed to provide knowledge about the soil resource including an assessment of soil capabilities for use in land management planning and decisionmaking, for resource development, and the protection of forest, range and related lands.

Soil scientists in the FS soil management program orovide the exoertise to secure and apply knowledge of the forest soil resource. They work with land managers and others to incorporate an understanding of soils in land and resource management activities to enable the FS to meet its land stewardship responsibilities. Some soil scientists are deeoly involved in land management planning as team members, or in many cases, team leaders. Activities of the FS soil management program as performed bv soil scientists are grouped into seven categories.

(a) Soil Resource Inventory - The systematic examination of soils in the field and laboratory including descriptions, classification, and mapping of soils and the interpretation of soils according to their productivity and behavior under use and management. . Included in this activity is the NCSS when the FS is a participant.

(b) Soil Science Suoport Services - The develonment, transfer and aoplication of soils knowledge to support the several resource systems and the management activities within them.

(c) Soil Qualitv Management - The develoomment and aoplication of management practices to maintain, restore, or improve levels of soil productivity on selected areas of land. It also includes the periodic evaluation and monitoring of soil conditions by review and measurement of soil parameters at key sites.

(d) Special Studies - A wide range of activities that generally involve adaotation of research or field experience to an operational program. The results of special studies and investigations may be presented in publications, handbooks, or management guides.

(e) Data Management and Analysis - The development and use of systems for collection, storage, retrieval and analysis of soils data for use by management, including remote sensing technology.

(f) Training - Formal and informal training to upgrade the expertise of soil scientists and to increase the understanding of soil resource management by land managers and other specialists in all phases of forest and rangeland management.

(g) Cooperation - Interaction with individuals and organizations in soil science and related fields outside the NFS. These may include, but are not limited to, Forest Service Research, State and Private Forestry, universities, professional societies, other government agencies, and private organizations.

Most of our efforts to date have been directed toward soil resource inventories for use in our current land management planning efforts. To date, we have completed soil surveys on 131 mm acres of National Forest System land. This represents 70% of the total acreage of NFS lands. Most of this acreage consists of third and fourth order surveys. Included in this total are approximately 30 mm acres of surveys done cooperatively within the National Cooperative Soil Survey. Our goal is to complete soil resource inventories suitable for land management planning, on all National Forest System lands by 1985. At our present rate of accomplishment, we should achieve this goal.

Questions have been raised concerning the relationship of the Forest Service soil resource inventories and the National Cooperative Soil Survey. During the joint Soil Conservation Service - Forest Service coordination meeting in January 1976, it was mutually agreed to review this relationship: As a result, a joint task force was designated with the charge to review the goals of each agency with respect to the procurement and use of soil information. A document was to be prepared that could be distributed to field offices in order to enhance mutual understanding and cooperation in this area of effort. This document has been completed, and has been approved by the Chief of the Forest Service, and the Administrator for the Soil Conservation Service. Actions related to the recommendations of this report are being initiated by both agencies.

Recent legislation such as the Resource Planning Act of 1974, and particularly the National Forest Management Act of 1976, deal quite specifically with the concern for the basic soil resource of our Nation's forest and rangelands. Implementing this legislation is the responsibility of the Forest Service. However, since certain sections of these acts deal with the use and procurement of soils information on both Federal and private forest and rangelands, the Forest Service will be looking to the National Cooperative Soil Survey to play an important role in its efforts to meet the intent of this legislation.

NATIONAL COOPERATIVE SOIL SURVEY WORK/PLANNING CONFERENCE
Orlando, Florida - January 31 - February 4. 1977

BUREAU OF LAND MANAGEMENT SOILS ACTIVITIES*

I am pleased to represent the Bureau of Land Management at this conference. We appreciate the assistance received from the Soil Conservation Service in supporting our Soils Program. The major soils activities in calendar year 1976 were:

Cooperative Soil Surveys

There were about 5 million acres of surveys underway in 1976. Most of this was through agreements with the SCS. A total of 153,000 acres was contracted in Oregon to private firms.

BLM Soil Inventories

BLM soil scientists in Oregon mapped about 20,000 acres. Mapping unit components consisted of phases of soil series.

12,000 acres - Order 2

8,000 acres - Order 3

Energy Minerals Rehabilitation Analysis (EMRIA)

The BLM has contracts with the Soil Conservation Service and the Bureau of Reclamation on proposed coal mineral development areas.

SCS	250,000 acres	Montana, Wyoming, Colorado, Utah
BR	7.500 acres	New Mexico, Wyoming, North Dakota

WC&D Phase I Inventory

The Watershed Conservation and Development erosion inventory is about 95% complete in the 10 Western contiguous States.

Detailed Requirements Definition (DRD)

This study was initiated to identify elements by functions within resource activities (Watershed, Wildlife, Range, etc.)to inform ADP personnel of the kinds of resource data that are being collected. The Bureau will be correlating its soils data with the SCS pedon coding system.

* LeRoy A. deMoulin, Principal Soil Scientist
Division of Watershed, Bureau of Land Management, USDI
Washington, D.C.

The Bureau of Land Management has entered into a new era in administration of the National Resource Lands (NRL) resulting from the Federal Land Policy and Management Act of 1976 (P.L. 94-579). The Act includes requirements that coordinated resource inventories be conducted on the NRL to provide basic information for action programs.

Other recent changes in Bureau Program responsibilities led to the need for a study to determine the role of the Watershed Activity. This study has identified the functional responsibilities and is in the process of determining staffing requirements.

A major recommendation of the study team was that the Division of Watershed be designated as the Bureau focal point for the Soil Resource Program. A number of responsibilities in water, air, vegetation, and geology that relate to other Bureau programs are also recommended in this study for assignment to the Division. We expect the Director to give his decision on the study recommendations in a couple of months. Meanwhile, the Division of Watershed has assumed the responsibility for the Soil Resource Program.

An evolving concern for the environment and subsequent court decisions are some of the events that have caused the BLM to press for more basic resource data. Soils data that can be used to predict the impact of a given management situation and help determine best management practices on the NRL, until recently, have been near non-existent. NEPA, environmental organizations, and other forces have demanded a higher degree of sophistication for use of soils data. In the past, BLM has obtained most of its soils information on small areas through contracts with Federal and State agencies for specific problems and research.

It is necessary, therefore, to provide soils data for project site productivity, allotment management plans, and to help meet environmental statement deadlines in the grazing program. This is the most immediate need in the 10 Western contiguous States because the program requires coverage of most of the NRL. There are about 100 million acres to be inventoried in the next 12 years in addition to older inventories that must be updated. It will be difficult to reach this goal, but we have no choice if we are to meet other commitments dependent on this information. The question now is, "What is the most timely and economical method to obtain adequate soils data for planning and operations"?

The development and use of Orders of Soil Survey have been beneficial to the Bureau in helping to establish rapport with management when discussing needs for soils information. Experience also is helping to establish a minimum level of mapping detail and determine what kind of soils information is needed for management interpretations. A mandate of Public Law 94-579 is that there shall be a systematic approach in the development and revision of land use plans to achieve integrated consideration of physical, biological, economic, and other sciences. Soil inventories must be coordinated and correlated with other resource inventories to satisfy this requirement of the Act. These inventories must not be considered just for a single use because of the immediate needs of the grazing program. Interpretive data also are needed for the Minerals, Lands, Recreation, Wildlife, and Forestry Programs. A Third-Order soil survey identifying phases of soil series will provide information to adequately assist in determination of best management practices for most BLM action programs. In some areas a Fourth-Order Inventory may be satisfactory. Consociations and associations consisting of phases of soil series must be the dominant mapping units where a Third-Order soil inventory is conducted on rangelands, timberlands, and wildlands.

We are seeking to determine the minimum requirements for soil resource data and we should not settle for less because of the magnitude of the job or established time constraints. For example, the soils data needed to quantify potential vegetative growth must be obtained from no higher than the series category, especially in the Northern Great Plains where slight differences in water-holding capacity strongly influence forage production. Productivity of some of the Southwest desert soils may be shown in terms of soil families where very low total precipitation or seasonal distribution may have a greater influence on plant growth than do combined soil water-holding properties.

The Bureau is moving toward future environmental statements prepared with procedures that will quantify vegetative growth in terms of soil productivity. Therefore, the BLM must establish uniform procedures and sampling techniques and revise its Manual instructions and guidelines to ensure uniformity. A team of resource personnel will be assembled in February 1977 to determine exactly what kind of soils information is needed. A modification of general field procedures and mapping unit design will also help to meet Bureau goals.

The Bureau intends to follow procedures established by the National Cooperative Soil Survey as closely as possible when mapping and classifying soils on the ML. Our soil inventories are intended for Bureau programs and generally will not emphasize soil correlation; thus, avoiding lengthy delays in processing information. However, soils will be classified and interpreted without conflicting with NCSS procedures. We have begun our own soil mapping using this system to take advantage of existing data on adjacent lands and to avoid costly duplication of efforts and conversion of data at a later date. We have demonstrated in Western Oregon that we can map vast areas of difficult terrain and provide adequate interpretive data for the Forestry Program and other activities with a Third-Order soil inventory.

Our Soils Program includes soil inventory operations, interpretations and special investigations such as contracted studies and research. We are developing the program to include those soils functions that will provide the Bureau with adequate soils information to protect and enhance the soil resource, as well as provide data to support all activity programs. This means we will need quality soil inventories. No longer can we look at our rangelands and forest lands, and with a wave of the hand, map them as rough, broken, and stony land, or as mountainous uplands.

We have a limited staff of about 45 permanent soil scientists. This number is expected to double in the next 4 years, but we do not expect to reach the capability to conduct all soil inventories internally. The major duties of District and Area Office soil scientists are to provide assistance to Area Managers through recommendations for action programs, and to help prepare environmental reports. Their roles and responsibilities in the District and Area Offices are variable depending upon local program emphasis. The major emphasis is in the energy minerals, grazing, and forestry programs. Other programs are not less important, but these are dominant in terms of impacts affecting the national economy and in land area that must be inventoried.

In most Districts the BLM depends on outside assistance to gather basic soils data while our soil scientists are performing other operational activities to support District programs. However, this is not the most desirable arrangement from a long-range planning view. It would be best for the Bureau and for individual professional development if the soil scientists gather basic soils information on the land where they develop use recommendations and have responsibility in the impact of management practices. The trend in the Bureau is to have the soil scientist concentrate on the job he was formally trained for as we begin to hire more specialists to do the jobs demanded by recent legislation and court actions.

The BLM soils program is experiencing "growing pains" and we have some expected difficulties such as recruitment of experienced personnel and development of uniform operational procedures. We need to improve our efficiency and capability to inventory and provide interpretations to meet today's demand of multiple land use management. Some of the challenges ahead are to obtain the dollars and manpower for the job, and to adequately train our sail scientists to increase their proficiency while making timely soil inventories. The BLM and cooperating agencies must determine the extent of their capabilities to gather resource data on the public lands while meeting their other commitments.

We need to develop equitable cost sharing arrangements as well as explore ways to obtain the needed manpower. New mapping procedures must be developed to enable coverage of the Western rangelands in a short time while maintaining quality control.

REPORTS OF AGENCIES PARTICIPATING
IN THE NATIONAL COOPERATIVE SOIL SURVEY

U.S. Department of the Interior
Bureau of Reclamation Activities 1/

William B. Peters 2/

Soil Science and related activities of Reclamation programs primarily relate to water and land resource development. They include economic land classification in selecting lands for irrigation; wetland surveys, and drainage and reclamation of salt-affected lands on existing irrigation projects; soil characterization for irrigation scheduling; revegetation of lands disturbed through construction of project features; reclamation of lands to be surface mined of mineral deposits; land and water appraisals for environmental studies; remote sensing research; predicting quality of return waterflows into drainage systems; water quality control, particularly salinity of major river systems; soil investigation for other agencies; assistance in selection of lands for irrigation to foreign countries and international financing organizations; and participation in interagency affairs, on committees, at workshops, and professional societies. The work on reclamation of lands to be disturbed by mining is performed for the USDI Bureau of Land Management through contractual arrangements.

It is Reclamation's practice to utilize USDA-SCS soil survey information to the fullest extent possible in all activities for planning, construction, development, settlement, operation and maintenance, and rehabilitation of projects. In this regard, Reclamation is very much interested in the new approach by the Soil Conservation Service to soil surveys, i.e., the concept and use of soil potential and related requirements in predicting and integrating land and management factors.

Predicting the Quality of Irrigation Return Flows

Under the leadership of Dr. Marvin J. Schaffer and Mr. Richard W. Ribbens, Reclamation has developed a computer simulation model which predicts both

1/ Brief report prepared for the Work Planning Conference of The National Cooperative Soil Survey sponsored by the U.S. Department of Agriculture Soil Conservation Service, Orlando, Florida, January 30-February 4, 1977.
2/ Head, Land Utilization Section, Resource Analysis Branch, Division of Planning Coordination, Engineering and Research Center, U.S. Department of the Interior, Bureau of Reclamation, Denver, Colorado.

the quantity and quality of subsurface return flows from irrigation. The model has been applied to Reclamation projects in the Northern Great Plains, the intermountain West, and California. Portions of the model or the entire model itself are in use throughout the Western United States and in foreign countries.

Physical, chemical, and biological processes are simulated within the soil root zone, the unsaturated zone in general, and the aquifer. Subprograms within the model can be utilized alone to make projections concerning the reclamation of salt-affected lands, the most efficient use of fertilizers, the design of drain spacings, and pollution of the aquifer.

The model currently simulates concentrations of major cations and anions, and nitrogenous species. Reclamation intends to expand its capabilities to include phosphates, pesticides, and trace elements. The model may be extended to include acid soil conditions.

Research is in progress to obtain additional verification of the model on large-scale irrigation projects and to determine the best method(s) to select or obtain respresentative field data.

Assistance to the Developing Countries

Reclamation has provided technical assistance in the field of multiple-purpose water resource development to over 108 developing nations. This assistance has been highly varied, encompassing many disciplines, including engineering, economics, geology, hydrology, soil science, agronomy, and environmentalism. It can be reduced to three broad categories: (1) the gratifying task of training foreign nationals in our facilities at home, (2) providing direct consultation on various aspects of water resource developments abroad, and (3) the challenge of water resource planning abroad, accomplished with counterparts from the host nations. The latter primarily involves early reconnaissance-type investigations and preparation of reports to the governments requesting these services. Detailed feasibility studies, design, and construction are usually carried out under contracts between the governments and private firms. The work is helping through mutual effort to unleash the grip of economic stagnation and the corollaries of poverty, hunger, and substandard living.

Reclamation is currently, through the United States Agency for International Development, providing assistance in irrigation suitability land classification to the Niger River, Senegal River, and Gambia River areas in Western Africa.

Preplanning for Reclamation of Lands To Be Disturbed by Mining of Coal

The studies for BLM on reclamation of mineral areas are in response to the "coal rush" in meeting the energy crises. The objective is to identify optimum coal-leasing sites having superior potential for reclamation and to formulate lease stipulations. This involves obtaining basic data; making evaluations; and developing standards, guidelines, techniques, and alternate plans for land rehabilitation and restoring vegetative growth. The plans include recommendations for deposition and treatment of overburden and measures required to minimize environmental impacts, air and water pollution, and to promote safety. Environmental planning, design, and engineering are a very important aspect in formulation. Where viable alternative opportunities for enhancement are identified, plans are developed as requested by BLM. Alternative land uses and potentials might include rainfed agriculture differing from present cover and enterprises, irrigated agriculture, wildlife habitat, recreation, homesites, industrial developments, and others. In this planning, analysis is made of land use problems and opportunities associated with water plans, recognizing the natural and a modified land base, existing and potential land use patterns, zoning regulations, and general relationships to environmental, social, and economic aspects of the setting. All plans developed include an assessment of cost and benefits.

The work is approached on an interagency and interdisciplinary basis. Reclamation, in cooperation with the USDI Geological Survey, is exploring and characterizing overburden;3/ surface and ground water; and developing and analyzing data with respect to geology, engineering, plant science, hydrology, soils, drainage, economics, ecology, environment, and other relevant considerations. The investigation with respect to lands largely involves characterizing the overburden for reclamation potential and determining land use suitability. In characterizing overburden, sufficient exploration and drilling are accomplished to describe and collect representative samples of soil and substrata to a depth below overburden and coal (maximum depth of 200 feet). The description of soil and substrata characteristics in relation to land characterization essentially conforms to the USDA National Cooperative Soil Survey procedures. Sampling of overburden at master sites and agronomic laboratory testing are on a comprehensive basis. At the other explorations and borings, representative samples are selected for laboratory characterization on a screenable basis to confirm judgment in field appraisals.

The first priority in the agronomic laboratory characterization of soil is directed toward direct and indirect measurements to evaluate soil structure and its stability, effective soil-cation-exchange-capacity, and soil reaction. After this is accomplished, then consideration is given to testing that confirms the field characterization, explains the causes of phenomena previously observed or predicted, reveals the presence of toxic

3/ Overburden is the material consolidated or unconsolidated overlying the coal.

substances (salinity level, boron content, alkali, acidity, reduction products, etc.), and indicates measures required to cope with the soil deficiency under eventual field conditions.

Selected samples found by the laboratory testing to represent a range in properties conducive and adverse to establishment of vegetation are further subjected to greenhouse studies at the Colorado Experiment Station, Fort Collins, Colorado. These greenhouse and related studies are designed to establish possibilities and methods for establishing vegetation. Where these studies identify or detect unforeseen toxic conditions or soil deficiencies not susceptible to amelioration by established procedures, a program of applied research is recommended.

A product of the characterization with respect to land is a resource map reflecting both the present condition and future conditions under alternative plans for reclamation and restoration. The Soil Survey aspects are coordinated by BLM with SCS at State and local offices. The USDA Forest Service Surface Environment and Mining (SEAM) serves as a consultant to BLM on coordination matters.

Concurrently with the above-described investigations, the overburden is also characterized for geological, hydrological, and engineering properties. The USGS is responsible for ground-water data collection.

This work was initiated in 1974 and completed in 1975 at four specific sites, comprising about 2,000 acres each, located near Ashland, Montana; Hannah, Wyoming; Meeker, Colorado; and Kanab, Utah. Similar studies at six additional sites were initiated in 1975 located near Dickinson, North Dakota; Ashland, Montana; Rawlins, Wyoming; Gillette, Wyoming; Steamboat Springs, Colorado; and Farmington, New Mexico. Field studies on these six sites have been completed and reports are in the final stages of preparation. Studies were initiated on four sites in 1976. These are located near Fannington, New Mexico; Steamboat Springs, Colorado; Beulah, North Dakota; and Miles City, Montana. Experience gained to date from these studies and consultations with others disclose rehabilitation of disturbed lands can be accomplished using procedures already developed. Soil testing and soil fertility evaluation are sufficiently advanced to prescribe optimum management practices for most conditions. Research is underway to further develop plants for erosion control. The principal obstacle precluding successful rehabilitation of disturbed lands has been the general lack of coordinated planning among disciplines, agencies, organizations, and activities. Mr. Hubertus Mittman of the USDA Forest Service has emphasized the need for greater involvement and increased action by persons experienced in planning. Problems have to be anticipated and alternatives considered from an interdisciplinary standpoint.

Reclamation has applied its acquired experience in revegetation of disturbed lands related to canal construction, borrow pit excavation, backfill of project drains and damsites, and maintenance roads construction activities. Reclamation's activities require adequate staff capabilities, facilities, and administrative "know how" to coordinate the varieties of disciplines and activities related to resource development and environmental protection.

Irrigation Management Services Program

The Irrigation Management Services is a program developed by the Bureau of Reclamation to direct and assist irrigation and water districts in establishing programs to promote more effective and efficient use of their water supply. It is directed toward better onfarm water management and to extending water management through the distribution and storage systems. While the program was initiated primarily as a research effort, the beneficiaries of the program are expected to financially support these programs in their operational stages, The results of these program efforts will be applied in the design of new projects and the rehabilitation of irrigation systems. The establishment of the Irrigation Management Services Program on irrigation and water districts is a cooperative effort with the Soil Conservation Service and the State Extension Service.

Colorado River Water Quality Improvement Program

The purpose of this investigation is to develop plans for controlling salinity inthe lower reaches of the Colorado River to meet salinity standards set on the lower main stem. The mineral burden of the Colorado River is the foremost water quality problem in the basin and carries both interstate and international implications. Continued development of the water resources is expected to generate additional salinity increases with concomitant economic losses to agriculture and M&I users if the salinity is not controlled. Natural sources contribute most of the salinity to the river. Return flows from irrigation and municipal and industrial uses also add significant quantities of salt. Moreover, concentrating effects are produced by water exports out of the basin, use of water by vegetation, and evaporation from free water surfaces. This investigation program will consider individual problem areas, develop control plans, and make specific recommendations for remedial action.

Under the program, feasibility plans are being prepared for control of salinity from irrigated areas, as well as point and diffuse sources. Four of the original projects have been authorized for construction and advance planning activities are underway. Definite Plan Reports are being prepared for the Paradox Valley, Grand Valley, and Las Vegas Wash Units. The Crystal Geyser Unit construction has been deferred due to decreased cost effectiveness. To date, the program findings on salinity sources are pointing toward a need to emphasize a total water management approach to salinity control. Support studies involving the preparation of a mathematical model for management of the river, economic evaluation of water quality, institutional, and legal review have been made. Preliminary work has been completed on the applicability of ion exchange technology.

On the irrigation sources, irrigation scheduling techniques to improve irrigation efficiency are now being applied to 7,000 acres in the Grand Valley area, Colorado; to 9,800 acres in the Palo Verde Irrigation District, California; to 12,000 acres on the Colorado River Indian Reservation, Arizona; to 3,000 acres in Lower Gunnison Basin; and to 6,000 acres in the Uinta Basin of Utah. To assure effectiveness in irrigation source control, feasibility studies of the conveyance and drainage systems are being made to disclose improvements that could be made which would achieve reductions in salt loading, Feasibility studies on point sources at LaVerkin Springs and Littlefield Springs in Utah and Arizona are to be completed in FY77. All other point sources and diffuse sources in the program involve basic data collection as a prerequisite to report preparation. These include Glenwood-Dotsero Springs, the Meeker Dome. and McElmo Creek in Colorado; the Price, San Rafael, and Dirty Devil Rivers in Utah; and the Big Sandy in Wyoming. On the latter, pilot studies have been undertaken to appraise efficiency of desalting the water using natural freezing, involving the use of the natural cold temperatures in the area to freeze the water and thereby remove most of the salt. Cooperative research with the USDA Agricultural Research Service has been started to evaluate the relationship between high irrigation efficiencies and reductions in salt loading. Land and channel processes contributing to diffuse salt loading are being examined by Utah State University and Colorado State University.

Land Use Planning

The Soil Science Training Institute conducted at Colorado State University, commencing in 1974, was modified and supplemented to comprise a Land Use and Water Planning Institute for the years 1974 through 1976. The Institute was conducted under capable direction of Dr. Robert D. Heil. The objectives of the Institute ware to broaden and upgrade the knowledge of planners in the field of land use planning and to emphasize the important interrelationships between water and land development and use.

The 1974 course was structured to provide management-level personnel an overview of the interface between land use and water planning. The course emphasized the principles of good land use planning including the physical, economical, biological, political, sociological, and other factors which are important in the development of viable land use plans.

It has been the intent that subsequent courses be directed toward needs in broadening and attaining greater technical. proficiency among workers actually involved in investigations.

The Institute, as conducted in 1975, emphasized the physical factors inherent in the land use and water planning process. Such factors included soils, geology, geography, ecology, revegetation of strip-mined areas, hydrology, archeology, anthropology, and others.

The Institute for 1976 emphasized nonphysical factors involved in the planning process in relation to the Principles and Standards. These included, but were not restricted to, economics, the legal aspects involved in water development projects, social implications, public involvement, a discussion of national policy toward water development, data acquisition and interpretation, demography, and the preservation of agricultural lands from a political viewpoint. The physical factors as presented at the 1975 Institute were again generally reviewed as being required in the complete planning process.

Remote Sensing Research

Reclamation continues to support research in remote sensing for many applications including land classification. Most of the Soil Science activities have been in cooperation with the EROS Program and directed toward development of methods to assist in better identification of depths to water table, surface water accumulation and drainageways, vegetative cover and crop identification, depth to root and water impeding barriers, and gross soil features including soil moisture and salinity.

Land Classification

Summaries on land classification activities by States are presented in tabular form on table 1.

Table 1

IRRIGATION SUITABILITY LAND CLASSIFICATION

Fiscal Years 1977 and 1978

California

Allen Camp
Butte Valley
Lake County
Mid-Valley, Raisin City

Solano County
Sacramento River Seepage Project
Napa County
Ventura County
Yolo county

Colorado

Animas-La Plata Project

San Miguel Project

Idaho

Middle Snake River area
Salmon Falls Project
Upper Snake River area

Oakley Fan Division
Southwest Idaho area
Ririe area

Kansas

Kanopolis Unit

Montana

Upper Missouri River Basin Project

Flathead area

New Mexico

Animas-La Plata Project

Jicarilla Apache Indian Reservation

North Dakota

Garrison Unit

Apple Creek area

Oklahoma

Oklahoma State Water Plan
Southwest 20 counties

Waurika Project - Northwest 44 count .es

Oregon

Grants Pass Irrigation District
Warm Springs Indian Reservation
Merlin Division

Medford Division
Umatilla Basin Project
Tualatin Project
Baker Valley

Table 1--Continued

South Dakota

Oahe Unit	Grass Rope Unit

Utah

Central Utah Project, Bonneville Unit	Uintah Unit
Leland Bench Unit	Ute Indian Reservation
Upalco unit	

Washington

Yakima Indian Reservation	Bumping Lake Enlargement
Spokane Indian Reservation	Omak East
Columbia Basin Project	Benton Irrigation District
Yakima River Basin	Kalispel Indian Reservation
Colville Indian Reservation	Brewster Flat
Touchet Division	Kittitas area
Kennewick Division Extension	Oroville-Tonasket Project

Wyoming

Sublette area	Shoshone Project, Polecat Bench
Riverton Project	

Report from U.S. Geological Survey to the Work Planning Conference of the National Cooperative Soil Survey, Orlando, Florida, January 30 through February 4, 1977

Report made by James R. Anderson, Chief, Geography Program,
Land Information and Analysis Office,
U.S. Geological Survey, Reston, Virginia 22092

The Soil Conservation Service and the Geological Survey have a memorandum of understanding relative to the exchange of data and program coordination. The invitation to the USGS to participate in this Work Planning Conference is one of several ways by which exchange of data and program coordination has been occurring during recent months.

I will briefly report on some activities and research that should be of interest in the context of this Work Planning Conference. I have also brought along some materials pertaining to the status of orthophotoquad releases, 1:100,000 and 1:50,000 scale maps, land use/land cover mapping, the operation of the National Cartographic and Information Center, and the Land Information and Analysis Office, which has been established since the last Work Planning Conference was held 2 years ago.

In May 1975 a cooperative agreement was signed between SCS and NCIC. Under this agreement SCS provides NCIC with indexes of completed soil surveys and addresses from which they can be obtained in order to assist in providing users with information about soil survey availability. NCIC is providing standard formats for aerial imagery information, issuing catalogs, indexes, newsletters, etc., and assisting SCS to provide NCIC information to users whenever SCS so desires.

In the Topographic Division intermediate-scale base maps for the support of area studies and planning activities are being compiled at scales ranging from 1:50,000 to 1:125,000 with major emphasis on 1:100,000. These maps are being derived from existing 7.5 and 15 minute topographic maps with some updating. Major support for this program is coming from SCS. A status map indicating progress may be obtained from NCIC.

About 4,000 orthophotoquads were prepared in 1976 and 5,000 to 6,000 are scheduled for FY 1977. GS is presently preparing about 1,200 orthophotoquads annually for SCS for use as bases for soil surveys. A status index is available from NCIC.

In the Water Resources Division hydrologic studies are being conducted at sites in the coal regions of western United States that have high potential for leasing and mining. The soils are sampled in the fall and spring to coincide as near as possible with maximum wet and maximum dry conditions. These data are used to obtain estimates of quantities of water stored in the soil and evapotranspired. Changes in bulk density of soil with depth are also measured in order to compute quantities of moisture stored. Moisture retention capacity and the hydrologically active depth of soils are determined as part of evaluating rehabilitation potential at mined sites. Wherever possible, these studies are correlated with SCS soils survey data in order to increase the transfer value of our work to nearby areas with mining potential.

In the Geologic Division the mapping of surficial deposits is being done for a number of purposes including the study of individual landslides and the study of faults and ground motion needed in connection with nuclear reactor site investigations. Also in the Geologic Division, maps of the United States are being prepared at a scale of 1:7,500,000 as a part of the National Environmental Overview Program. Included are maps of surficial geology, volcanic hazards, karst, swelling clays, areas susceptible to erosion by "off the road vehicles," quaternary dating techniques, and a lithologic map. Work on landslides is being expanded to include a nationwide inventory, establishment of an information center, mapping in critical areas, and further research on processes involved.

The Branch of Regional Geochemistry of the Geologic Division currently has two research projects in soils geochemistry. In the Energy Regions soils project, a reconnaissance geochemical survey of the soils in the western United States energy lands is being made with primary emphasis on the magnitude of regional geochemical variation. The second project is a study of trace element availability in soils. Knowledge of element availability, as opposed to total element concentration, is critical in mined land reclamation.

In the Land Information and Analysis Office which has been created since the last Work Planning Conference, the need for closer interaction between the compilers of earth science data and land-resource planners and decision makers is being recognized. The five programs of this office are: Earth

Resources Applications Program, Resource and Land Investigations Program, Geography Program, Environmental Impact Analysis Program, and the Earth Resources Observation Systems Program (EROS).

Activities and research include urban area studies in several urban centers such as the San Francisco Bay Area, Pittsburgh, Puget Sound, and Denver, land use/land cover mapping to provide baseline maps and statistical data for the U.S., operation of the EROS Data Center at Sioux Falls, South Dakota, preparation of environmental impact statements, and the publication of several bulletins, professional papers, and other reports and articles. Some examples are:

"ERTS-1 - A New Window to Our Planet" (Professional Paper 929)

"A Land Use and Land Cover Classification System for Use with Remote Sensor Data" (Professional Paper 964)

"The Environment of South Florida, A Summary Report" (Professional Paper 1011)

"Directory to U.S. Geological Survey Program Activities in Coastal Areas 1974-76" (Bulletin 1428)

"A Guide to State Programs for the Reclamation of Surface Mined Areas" (Circular 731)

Summary of Research Studies
Sponsored by the Federal Highway Administration
for which SCS provided assistance

Donald G. Fohs*

My main purpose this afternoon is to describe several research studies in which the Federal Highway Administration has relied on and received assistance from the Soil Conservation Service. However, in order to provide some background for these studies, I'd like to briefly describe the mission of FHWA and those programs appropriate to the description of these studies, developed to accomplish FHWA's mission.

The Federal Highway Administration is one of eight operating administrations of the Department of Transportation. The Federal Railroad, Aviation, Urban Mass Transportation and Coast Guard being the other modal agencies in the Department. The overall objective of the FHWA is to provide leadership and programs for the development of a highway transportation system that will effectively satisfy national, regional, and local requirement for the movement of people and goods, while maintaining a balance with other nodes of the national transportation system. As in any other enterprise, the role of research and development is to harness existing technology and to create new technology to solve problems encountered.

In order to effectively carry out it's mission the Office of Research has developed a Federally Coordinated Program of Research and Development in highway transportation, which is often referred to as the FCP. The studies I plan to discuss are among some 900 studies that comprise the FCP. The FCP is an array of some 55 research projects directed toward solving the most urgent problems facing local, State and Federal highway officials responsible for the planning location, design and operation of transportation facilities.

The FCP was formulated in 1970. The structure of the FCP was developed to provide a framework for both public and private research groups to work in a united approach to the solution of major identifiable problem areas in highway transportation. The major problem areas were classified into categories, of which there are presently nine, with each category divided into projects, presently about 55, and each project divided into tasks. One or more studies are then conducted to accomplish the objectivies of a given task.

The overriding emphasis in the FCP coordination in that it is a program that promotes the participation by others based on the concept that the most productive and efficient method of achieving its goals is to coordinate and complement the research efforts of others.

*Chief, Soils and Exploratory Techniques Group
Materials Division, Office of Research

Category 4 is devoted to improving the performance of presently used materials and developing new materials for highway construction. One of the projects under Category 4 concerns the development of methods for measuring and improving the performance of soil and rock materials for the construction of highway pavement base courses, subbases and subgrades.

Perhaps the oldest method for improving soils for engineering uses is that of soil treatment with quick lime or hydrated lime. Although lime has been used since the end of World War II in highway application, many differences existed in the engineering properties and performance of the altered soil materials treated with various limes. With increasing use of lime stabilized fine-grained soils for pavement construction, necessitated by the depletion of aggregates caused by construction of the Interstate Highway System, a study was undertaken to elucidate those soil and lime characteristics responsible for performance.

This study,[1/] which was conducted by the Portland Cement Association, has two broad objectives. First, to determine the role of magnesium and the relative effectiveness of calcitic limes and dolomitic limes in the stabilization of a wide range of U.S. soils. In addition, the Soil Conservation Service was charged with the task of selecting and obtaining a number of soils representative of major U.S. soil areas and suitable for stabilization with lime. Thirty-five clay soil samples representative of U.S. Soil Series were obtained and treated with hydrated calcitic and dolomitic limes, some of which were obtained from commercial sources and some were manufactured in the laboratory. In all, 14 limes were used in the study.

The major criteria for evaluating the lime-soil-water systems was the effects of the properties of the system components on the unconfined compressive strength of compacted specimens. The change in soil strength of compacted specimens provided by lime treatment is often referred to as a soils lime reactivity. The limes used represented different properties produced by factors such as type of kiln used for calcining, burning time, burning temperature, lime type, composition and source of limestone etc. The soils sampled represented differences in the amount and type of clay minerals, amount of amorphous and organic material in the soil, cation exchange capacity and the specific ions occupying exchange sites, specific surface area and techniques used to prepare soil samples prior to lime treatment.

The major conclusion of the study was that for all practical purposes either calcitic or dolomitic monohydrate lime was equally effective for treating soils for engineering purposes. Several more detailed conclusions are listed below: 2/

1/ Administrative Contract No. DOT-FH-11-8159 "Role of Magnesium in the Stabilization of Soil with Lime"

2/ Report No. FHWA-RD-75-98 "The Role of Magnesium Oxide in Lime Stabilization," Volume 1, October 1976

1. Mineralogy was a significant factor in strength development. For example, the illite clays were not very reactive with the limes and did not develop as high a compressive strength as the montmorillonite or kaolinite clays.

2. Soil constituents had a significant effect on the strength development of lime stabilized soils. For example:

   a. carbonates as a soil constituent contributed to strength development.

   b. significant amounts of magnesium ions inhibited strength development when carbonates were not a soil constituent

   c. strength development of montorillonite soils increased with cation exchange capacity when magnesium ion or carbonate content were not significant

   d. for illite clays strength development depended primarily on minor soils constituents such as montmorillonite or amorphous silica content

   e. amorphous aluminum oxide soil constituents inhibited strength development of kaolinite clay soils

   f. low strength developed by the Cecil soil was due to the preferential reaction of gibbsite with calcium hydroxide. In addition, the formation of C-S-H gels were not observed with the Cecil soil.

3. C-S-H gels formed in perference with dolomitic monohydrate lime in the presence of montmorillonite clay constituents that were nonexpandable when glycolated rather than with hydrated calcitic limes.

4. Calcium silicate hydrate contributed to the compressive strength of soil-lime mixes.

5. The presence of greater amounts of aluminum ions in kaolinites promoted the formation of ghelenite hydrate that may contribute to strength development.

6. Noncrystalline, nearly amorphous reaction products, were observed by SEM at the edges of clay sheets, as reticulated network structures on the clay domain sheet and as dense coatings on particles (clay domains). The stronger soil-lime mixes exhibited the denser coatings and reticulated networks.

7. Greater amounts of crystalline reaction products were present in the soils with the greater strength gains. These products were identified as ghelenite hydrate, magnesium hydroxide, calcium aluminate hydrate, and calcium hemicarboaluminate.

8. Hydrated calcitic limes were more effective in reducing soil plasticity than dolomitic monohydrate limes.

Project 4C of Category 4 has as its objective to evaluate various waste products as material for highway construction and maintenance and to develop procedures for their use. One of the tasks in Project 4C is devoted to converting waste resulting from industrial production processes which occur in such quantities so as to constitute a potential source of pollution to the environment. Power plant ashes and waste sulfates are now under this study.

Sulfate wastes arise as byproducts from industrial processes of environmental control. For example, approximately 30 million tons of phosphogypsnm waste are generated annually from the manufacture of posphoric acid, 2 million tons of waste sulfate result from the desulfurization of power plants flu gases (it is estimated that by 1980 to 1988, this amount will increase to 100 million tons) and about 1 million tons is generated in the neutralization of acid mine drainage and steel pickling liquiors.

SCS's charge for this study was to assist the Midwest Research Institute 3/ in the selection and procurement of soil samples representing major soil series (large area1 extent) within a 100 mile radius of the various sources of sulfate waste. Samples of 31 soil series were acquired and used in a laboratory testing program. The main thrust of the testing program was directed toward evaluating the effects of sulfate waste addition on the unconfined compressive strength of the soils samples. In addition, the effects of sulfate waste, lime/sulfate waste, lime/fly ash, sulfate waste/cement kiln dust, fly ash/lime, sulfate waste/cement and sulfate waste/kiln dust lime systems on the strength of the soils were evaluated.

The major conclusion of this study 4/ were that sulfate waste alone has very little effect on the engineering properties of soil (strength, resistance to wetting-drying or freezing and thawing and shrink-swell potential) i.e., it acts as an inert, fine-grained non-plastic filler. The combination of sulfate waste and lime is an excellent material for increasing the strength of soil; the use of sulfate waste often reduces the amount of lime required for stabilization and increases the rate of strength development. The use of sulfate waste also permits the use of byproduct lime (cement kiln dust) for soil stabilization at lesser rates than when byproduct lime is used alone.

3/ Administrative Contract No. DOT-FH-11-S515 "Use of Sulfate Waste for Remedial Treatment of Soils"

4/ Report No. FHWA-RD-76-143 "Use of Waste Sulfate for Remedial Treatment of Soils; Vol 1, -Discussion of Results, August 1976 (in print)

The third study in which SCS participated involved the evaluation of chemical compaction aids. Annually, highway construction requires that several hundred million tons of soil be compacted. This study, 5/ conducted by Iowa State University, was directed toward evaluating the effectiveness of various chemicals for increasing soil density for a given mechanical effort, reducing the amount of effort required to obtain a specified density or reducing the amount of water required for compaction. The SCS was charged with assisting the researchers in selecting and obtaining samples of 25 soil series representative of the major soils in the United States. A further constraint was that the series should be representative of a range of clay mineralogies i.e., the number of soil series selected with montmorillonite predominant should be proportional to the amount of montmorillontic soils encountered in highway construction.

At the outset it was hoped that a general relationship could be established between the physical, chemical and mineralogical characteristics of the soil and the nature of the chemical compaction aid i.e., acidic chemicals are effective with basic soils, certain classes of chemicals are effective with montmorillonitic soils, etc. However, no consistent relationships could be established indicating that each soil-chemical system had to be evaluated individually. The primary output from this study is the development of simple, rational and rapid methods for evaluating the effectiveness of chemical treatment for improving soil compactability. To date, only a few of the some 30 chemicals tried have demonstrated a degree of effectiveness of any practical significance.

In closing, on behalf of the Federal Highway Administration, I'd like to express our sincere appreciation and that of our contractors, Portland Cement Association, Midwest Research Institute and Iowa State University for the cooperation and assistance provided by Drs. Bartelli and McCormack and all the Regional, State and County Soil Scientists of the Soil Conservation Service.

5/ Administrative Contract No. DOT-FH-11-8135, "Chemical Compaction Aids for Fine-Grained Soils"

Soils and Settlements: A Focus for Resource Planning

I appreciate the opportunity to be with you for your deliberations this week and to represent the viewpoint of the soil survey user. And I endorse your statement, Bill Johnson, about expanding the interchange between soil survey and other disciplines.

This afternoon I'll talk with you about soils and human settlements, a focus for resource planning. To introduce this I would like to share with you a recent experience.

A few months ago I visited that famous farming area known as Pennsylvania Dutch country. It was a Sunday morning--a Mennonite elder was talking to his audience of tourists about the Amish and the Mennonites. He told of their religion, culture, and history. The elder said that in the 1600's, because of religious persecution, Mennonite farmers left Germany to take up life where they could worship freely. Some came to the colonies of the Eastern Seaboard of North America, The elder said the farmers knew techniques for productively working the limestone soils of Germany. They were looking for these same limestone soils so they could continue to farm the same way. These farmers heard that limestone soil existed in Pennsylvania. Incidentally, the elder told us an old saying that Mennonites can smell limestone soil! At any rate, they migrated to the area east of the Susquehanna River in what is now southeastern Pennsylvania and began farming anew. Because of a particular soil, Mennonites settled in Pennsylvania and prospered. Because of this particular soil, today there are settlements with picturesque

---

Notes prepared for presentation by Ida D. Cuthbertson at the Work Planning Conference of the National Cooperative Soil Survey. Orlando, Florida, January 31, 1977.

names in Pennsylvania. Because of this particular soil, our national culture is enriched.

I relate this "Bicentenniel Minute" because it illustrates how soil has influenced human settlements in the U.S. and our cultural history. I relate this to you because, as a community planner, I am very much interested in the formation of human settlements.

There are other examples that relate soils co human settlements: The homestead lands, for example, and the handbill posted in the Swedish railroad station that told of soils of North Dakota.

Long after the frontier closed, soil continues to influence settlement patterns. We know only too well how the floodplains have been used, how the best soils for crops are planted with houses, (One wonders how many subdivisions across the country have the word "orchard" in their name.) Industrial parks occupy former cropland. Highways replace cropped acres, and render nearby acres useless for farming. And, as settlements grow, more agricultural acres are turned over to production of sand, gravel, and crushed rock for more settlements. This litany is familiar. And we've heard the response, "Why doesn't someone do something about this?"

"Doing something" is what resource planning is all about.

In SCS, resource planning refers to activities undertaken to help others to arrive at sound decisions regarding the usc and conservation of natural resources. These technical assistance activities include providing information on soil and water resources, flora, and fauna. Providing technical assistance means giving information on techniques for manipulating the soils to allow satisfactory accommodation of various uses. The term does not refer to providing dollars, as it does in some other agencies. Resource planning assistance is a natural outgrowth of conservation planning *assistance* that farmers and ranchers receive from SCS. SCS bases both resource planning and conservation planning assistance on the recognition that soil is one of the factors that should get early and major consideration when planning for the future. This is as true for community development as it is for farming. This unique assistance is available to all people who make or influence decisions that disturb soils or change the use of land.

Who are the people who make or influence these community development decisions? They are Land owners, land managers, or government officials with authority in land matters. These people are:

Developers

Bankers

Builders

Contractors

Land buyers, for both residential and commercial/industrial purposes

Elected officials of local government: Councilmen, trustees, town selectmen, mayors.

Appointed officials of local government: Members of boards, such as schools, recreation, health, planning, parks, or industrial development boards.

Heads and staff of local government agencies: Schools, parks, recreation, planning, public works, or health departments, including, of course,. the professional planner.

Members of milticounty boards.

Elected and appointed state officials.

Heads and staff of state agencies.

Officials and staff of national government.

Officials and staff of international government.

Add them up and you have many, many people in the private and public sectors--all with influence or authority over decisions regarding human settlements, the land and its use.

For a moment think about these people who influence these decisions. If you look at the country as a whole, the majority of these people are not professional managers or public administrators. Many serve voluntarily in what we call "after dinner government." They are lay people who are knowledgeable in their own fields of endeavor. but not particularly knowledgeable about soils, which we say is one of these factors that should get early and major consideration in the decisions affecting human settlements and land.

These informed, lay people need resource planning assistance. They need information on soil resources, on manipulating the soils. or reserving soil for specific uses. They need resource planning assistance to help ensure a quality environment in which to live, work, and play; They need this assistance to prevent mistakes which can be expensive. In today's economy of scarcity, preventing mistakes is very important in both the public and private sectors.

Some of these people who influence community and land decisions know they need resource planning assistance, and know where to get it. Others either may not know they need it, or may not know how to get it. You can help us to reach these groups. You can help "do something about it." Here are some ways you can help to reach these people who influence community and land decisions in the public and private sectors:

1. Invite these influential people to join in planning for the soil survey. Invite them early in the planning process. At this stage it may be easy to accommodate their special needs. Because they are in on the survey planning, they will be primed to receive resource planning assistance.
2. Talk to these influential people in lay language. Even better, save a thousand words by drawing a picture. We sometimes have difficulty when we try to explain complex, technical information. Think of the difficulty the listener has in trying to understand it! To be helpful we must be understood.
3. Present facts to these people who influence land decisions and then tell them why these facts are significant. A planning commissioner--a well informed layman-once said to me, "I think it is important that we know about soils when the Commission makes a recommendation on community development. But when someone tells me a soil is 'slowly permeable,' I'd like to know how slow is 'slowly'--four hours? Three days? Two weeks? And I'd like to know why this is important. And what the consequences are."

The Commissioner wants answers that help him make recommendations. We serve our own conservation goals as we enable others to be conservationists.

So here are three ways to link resource planning assistance and people who influence decisions about human settlements. Interestingly, a reverse process is also at work. People who receive resource planning assistance may be your first supporters when you seek funds to accelerate a soil survey.

For all your efforts to involve people in planning for a soil survey, to talk in lay terms, to explain the significance for their concerns--for all these efforts you will be rewarded with their highest regard. I am happy to share with you the praise that local officials and community planners accorded you last Spring. I wish you could have received it firsthand. The occasion was the joint meeting of the American Society of Planning Officials and the American Institute of Planners. At this meeting USDA had a large exhibit, including one display highlighting the prime farmland mapping program. The planners were very enthusiastic to learn of this. Each wanted to know when County X was scheduled for mapping. In talking with the planners who stopped at the exhibit, I took an unofficial poll. Many planners know of SCS and the soil survey. An even higher percentage of planning students do, which bodes well for the future. While talking to several hundred planners, many of them offered compliments. They know the soil survey as a basic reference of natural resource information, a very useful reference for planning at the community, regional, or state level.

We resource planners are grateful to you too. Your surveys are unique sources of information. As a measure of their usefulness you may recall that many of today's speakers refer to the disciplines and the public who use these unique documents. Your surveys are basic to our assistance. With your efforts and ours, and those of the developer and banker and builder and government official, we can look to the day when the soil always receives early and major consideration in planning for human settlements.

Thank you.

CARTOGRAPHIC DIVISION REPORT FOR
PRESENTATION AT THE
NATIONAL COOPERATIVE SOIL SURVEY
WORK PLANNING CONFERENCE
JANUARY 31, 1977

JEROME A. GOCKOWSKI

ADVANCED MAPPING SYSTEM

Introduction

The cartographic unit of the Soil Conservation Service has purchased, installed, and is in the process of checking out the Advanced Mapping System (AMS). The AMS was designed to produce any map needed by the Soil Conservation Service. Maps such as base, topographic, soil, and interpretive maps will be digitized, stored together with associated tabular data in computer format and then processed, analyzed, and retrieved as desired. Primary emphasis will be placed on digitizing soil data from published soil surveys, but any line data can be digitized such as land use, ownership, or any other type of information. Base maps will be prepared for interpretive maps or any other type of thematic map. The final product of the digitized soils and base maps will be different types of interpretive maps.

status

The hardware for the AMS was installed in February 1976. All hardware is working as required. The system is in operation but not in production. At the present time, we are debugging the software and looking for more efficient ways of doing different types of operations. The software commands are all complete, and we are working on more efficient commands and way of editing and entering symbols at a greater speed.

Mapping Applications

The maps generated by the system such as river basin, watershed, geology, resource conservation and development, or any other type of thematic maps, will be used for planning purposes by Soil Conservation Service personnel. Topographic maps will be prepared by digitizing at the stereoplotter, editing, and then final drafting on the system. To help you better understand the capability of AMS, some of the potential uses for the system are:

1. Base Maps - The following kinds of operations involving base maps can be performed by AMS without manual redrafting:

   a. Drafting of base maps for displaying resource data or interpretations, retaining selected culture or drainage features.

   b. Enlarging or reducing the scale of the original map while retaining proper line widths. If a photographic enlargement or reduction were made, it would result in line widths either wider or narrower than desirable.

   c. Elimination of specified types of *data* when maps are reduced. For instance, we can eliminate secondary roads or drains which would not be possible with a photographic reduction.

   d. Construction of a series of maps of the same area, each map showing a single kind of culture or drainage feature.

   e. Joining of selected portions of two or more base maps to form a composite base map: such as watershed map involving two or more counties or a soil survey area involving portions of counties.

   f. Joining an entire area of two or more counties and on the composite map showing selected culture or drainage features such as a base map for an RC&D area.

The following kinds of data can be stored for a base map, each on a separate layer that can be used alone or in combination with other layers. The user may specify the data desired such as:

(1) Political boundaries; national, state, county, township, city, village, other

(2) Boundaries of water areas

(3) Rivers or streams of different size and classification

(4) Highways or roads of different classification

(5) Cities or towns of different population

(6) Railroads

(7) Project measure locations

(8) Section lines

(9) Registration marks, longitude latitude, state plane coordinates

Base map data will be digitized principally from the 1:24,000 USGS map series although other controlled bases will be used as required to fill needs identified by SCS offices.

2. Interpretive and resource maps - The primary capability of AMS is the preparation of various kinds of interpretive and resource maps based on data encoded into the system. Several examples are as follows:

   a. Maps of areas showing specified percentage of slope or other individual soil properties

   b. Maps showing areas of prime farmland or other specified level of soil limitation or potential

   c. Maps showing the degree of limitation, potential, or productivity of an entire area of a town, watershed, or county

   d. Maps of water resource data including watershed, river basin boundaries, and so forth.

      (1) Maps delineating only those units greater than or less than specified size

      (2) Maps delineating only those units with specified water quality, drainage, recreational, or flood control needs

   e. Maps of vegetative cover, range site, or ecosystem maps

3. Topographic Maps - Topographic maps will be digitized at the time the contours are being plotted. All roads, streams, and other cultural information will be digitized along with the contours and cross-sections. These data will be used as input to other computer programs or plotted as a finished contour map.

4. Status Maps - From digitized base maps with county boundaries or boundaries of other administrative or project areas; progress or status maps can be prepared. Once such a file is created, the status map can be updated at a later date by merely programming changes that have occurred since the file was last updated.

5. Acreage Determination - For any map unit displayed on resource, interpretive or status maps, AMS will automatically measure acreage.

AMS Configuration

The AMS located at Hyattsville, Maryland, is configured around four subsystems. Each subsystem independently performs one or more operations. The system is made up of the scanning, identification, edit, and drafting subsystems.

1. Scanning subsystem - This device automatically scans and digitizes a sheet that has any type of lines. The lines can be contours or boundaries. Depending on the density of lines, the scanning time varies from two to eight minutes per soil map sheet.

2. Identification subsystem - Data from the scanner will be transferred to the identification subsystem. The identifying symbols for the areas, whether they be soil areas or some other type of area, will be entered at the keyboard. All lines will be identified in an interactive environment and will be tagged in the data base. Character recognition is not yet part of the system.

3. Edit subsystem - The edit subsystem has a high-speed ball point pen plotter which will produce a plot of the map. The plotted map will then be given to an editor for a thorough color check. Errors will be marked on an overlay and sent back. The corrections will be made to the data base through the graphic display screens (CRT's). After the maps have been edited and corrected, processing will take place to:

   (a) Join sheets together or section a portion of an area out of a larger area,

   (b) Adjust the information to the correct base,

   (c) Scale,

   (d) Prepare the interpretations,

   (e) Prepare color separations, and

   (f) Report areas in acres or hectares as required.

4. Automatic drafting subsystem - After the map has been completed, the final map will be drafted on the automatic drafting machine using a beam of light to expose photographic film for a high quality, finished product. The map can be plotted at any scale, with any line width desired.

5. Remote units - In addition to these four subsystems, we have installed remote units at each cartographic unit. Manual digitizers, computers with 64K memory, and edit screens are used to prepare base and thematic data tapes for all Service programs that are plotted on the automatic drafting subsystem.

AMS Capabilities

The system, as it is designed, does not have any analyzing capabilities. The system is a simple input and output device.

Analyzing capabilities will be added to the system after SCS defines their needs for this capability. At the present time many different agencies are working on computer programs to analyze data on different overlays such as topography, land use, vegetation, climate, land ownership, etc. All of these programs are different and require a different data input format, so they are not presently compatible. We are working with USGS on establishing compatibility in our computer mapping programs.

The output capabilities of the system are a high quality, photoplotted, finisheh map at any scale, showing required detail, with necessary color separations.

The accuracy of the system is based upon the accuracy of the input product The soils information that we will be digitizing has been surveyed and mapped at a scale of 1:15,840, 1:20,000, 1:24,000, and 1:31,000. The scanning system is highly accurate in digitizing the location of these lines from the input map. These soils lines will be adjusted to fit a 1:24,000 USGS base map. All data for the soils and base information will be filed at 1:24,000. Finished maps can be produced at any smaller scale and be very accurate.

Since the system is not in production, we do not have accurate cost data. The system was designed to digitize 80 average size soil surveys per year and produce interpretive maps for these soil surveys. At this time, we estimated that it willccost approximately $3,000 per county to digitize the soils data and then approximately $200-$400 each to produce an interpretive map.

This is a line segment-type system. All lines are filed away with coordinates at the beginning and ending point and all coordinates along the line. The soil symbols on either side of the line are also stored with the line. With this data base structure, we are able to produce polygons and cells for other types of computer programs.

Can AMS Prepare Press-ready Negatives for the NCSS Program?

The answer to this question is yes!

Procedures and costs were requested by Dr. Flach. They are being prepared. The proposed procedure will likely be as follows:

1. The state shall prepare the soil map compilation manuscript in pencil as they are now doing for the new procedure method;

2. The cartographic unit shall contract for the culture, drainage, and soil line and name overlays,

3. The culture, drainage, and soil line overlays will be scanned and processed, and then the soil symbols and names will be entered at the keyboard.

4. An edit plot will be drawn and sent to the state for edit, and

5. The cartographic unit will make the corrections.

6. The final negative will be drafted on AMS and ready for the press.

In conclusion, a group of Washington office staff members representing all SCS programs are studying the application of AMS. They shall recommend the priority areas of use for AMS.

Placing soils data into a data base shall provide the first building block of a total computerized data system for more efficiently carrying out Service programs. Our efforts to make AMS compatible with other agencies systems will reduce duplication of effort in mapping programs.

Report of the

Ecological Sciences and Technology Division

William J. Lloyd*

Ladies and gentlemen: I consider it a privilege as well as a pleasure to represent my division at this work planning conference. This is the second such conference for me as I attended two years ago here at Orlando. Some of you I know well. Many of you I have met once or twice before. Some of you are new to me. I am hoping I can gain a better acquaintance with each of you in the next few days.

Our prime interest is in soil interpretations. Other speakers have mentioned that a soil survey does not end with putting lines on a map. We look on the soils map as being only the skeleton of the survey. Through the development of needed interpretations we put the meat on those bones.

If you have an interest in soil interpretations, it follows that you must have a concern for soil survey design. This brings us to a situation much like the one posed by the question of which come first, the chicken or the egg. Soil scientists may say, “tell us what kind of a soil survey you want and we will produce it for you.” The plant scientists turn it around, “produce a soil survey and we will figure out how to use it.” This gives us a lead and follow situation. Soil scientists must involve the plant scientists in the design of the soil survey. Similarly, plant scientists must involve themselves. Unilateral actions can not be expected to produce desirable results.

An earlier speaker, Dr. Tefertiller, mentioned that because of the shrinking world in which we live it is essential that we know the potential for each soil for any possible use or crop. Soil potential has two parts or considerations. The first is the actual potential of the soil. The second is the knowledge of all limitations, hazards, and problems with which the user must deal and the understanding of what steps must be taken to overcome, sidestep, or compensate for those limitations.

The first consideration, the potential, is relatively easy to determine. The second consideration, coping with the limitations, is not so easy. As we crop or use land for any particular purpose, a fund of experience data will be developed. Our task is to document those experiences. Some users will make serious mistakes of which we should take note. Other users will synthesize new techniques or procedures which will prove successful. These we must note as well. It should not be necessary to reinvent the wheel more than a few times.

*Plant Sciences Division, SCS, Washington, D. C.

Hopefully, in a few years we will be able to array all soils in terms of their suitability for any crop or use. In the United states, we have soils which have forest cover, yet have a wood-producing potential of less than one half cubic meter per hectare per year (approximately seven cubic feet per acre per year). Other soils have a wood-producing potential of twenty cubic meters per hectare per year (approximately 300 cubic feet per acre per year). With such broad spread in potential there is a corresponding differential in economic opportunity. A nation wedded to the principle of free enterprise can not ignore such differential in potential.

Obviously we must make full use of soil survey interpretations to assure maximum inputs of labor and money to grow wood on the most productive lands and minimum inputs on the less productive. Many low-producing lands might well be dedicated to purposes other than wood production.

The recently completed prime farm lands inventory has stirred up a great deal of interest. I have been fascinated by the responses of the public to that inventory. The response indicates a quickening of public interest in land.

We must recognize that a generation of Americans has grown up who have not gone "over the river and through the woods to grandfather's house." A modern rendering of that song would have the singers taking Delta airlines or the Boston subway to grandfather's house. An urban society can not be expected to have emotional ties to the land as do people who worked on farms in their youth. Perhaps the prime land inventory has helped build an awareness that milk is not produced by a supermarket and 2 x 4's are not produced by a lumberyard. Hopefully, the public recognizes that we can no longer take the abundance of land as granted.

The Renewable Resources Planning Act of 1974 required the Forest Service to make an assessment of the nation's forest and range resources and develop a program for the conservation and development of those resources. The assessment was prepared under severe limitations of time and we must compliment the Forest Service for the comprehensive document which they produced. We are critical of the assessment in that no real attention was given to the National Cooperative Soil Survey as a base for planning. We feel that no assessment of natural resources is complete without full consideration of soil potentials and limitations as can be drawn from the soil survey.

In 1966 three agencies (Forest Service, Soil Conservation Service, and Extension Service) entered into a tri-partite agreement setting up guidelines for the forestry work of the Department. That agreement is now being amended to include the Agricultural Stabilization and Conservation Service as a co-signer. We are asking that the amended version recognize the soil survey as a basis for all land use and management planning.

I look forward to visiting with each of you during the remainder of the week. I will appreciate receiving any thoughts you might have as to how the Ecological Sciences and Technology Division can work more closely with you.

IMPORTANT FARMLAND INVENTORY

Raymond I. Dideriksen*

A recently completed Potential Cropland Study by the Inventory and Monitoring Division reveals that about 250 million acres of our 400 million cropland base is prime. Only 24 million acres of land in other uses but readily available for conservation to cropland is prime. A very small acreage, indeed for the U.S. Yes, there are more acres of land, about 87 million, that could be converted but not without invironmental costs.

Between 1967 and 1975, 2 million acres were urbanized each year in the United States and nearly 1 million acres a year were converted to lakes, ponds, and reservoirs. Another 12 million acres are currently being held for urban use.

As the food situation has gained attention, there had been a growing concern for the continuing conversion of the country's best agricultural land into other uses. From the rural couple in South Dakota who fought to prevent a borrow pit on their small acreage of corn ground to the county officials in Long Island, New York, working desperately to save some of the remaining vegetable farms from development we hear a similar message. Too many acres to top quality farmland are being converted to other uses.

With this settinp it is not difficult to understand whv one of the Division's activities, started in 1975 as a pilot effort involving 122 counties in the U.S., is rapidly demanding more of the Soil Conservation Service and the Department's attention. It is the Important Farmland Inventory. This inventory identifies, on a map, prime and unique farmland and additional farmlands of state and local importance.

Prime farmland is land best suited for producing food, feed, forage, fiber, and, oilseed crops. It is the land that is most productive; requires the least energy, fertilizer, and other inputs; has the fewest environmental hazards; and returns optimum profits to the farmer. Criteria for prime farmland are based on soil survey data.

Unique farmland is land used for producing specific high-value food and fiber crops. It is land other than prime, but is still very important because it has a special combination of site, soil, and climatic conditions that make it highly suited for growing a particular crop. An example of this "one-of-a-kind" combination is the tart cherry area of Michigan. States are responsible for determining which unique farmlands are to be inventoried.

Presentation by R. I. Dideriksen, Director, Inventory and Monitoring Division, SC'S, at the NCSS Conference, Orlando, Florida. January 31, 1977

Criteria for additional farmlands of state and local importance are determined by agricultural experts at the state and local levels. In general, farmland of statewide importance includes other lands suited for cropping while those of local importance may include additional lands that make up a viable farm unit or farm community. Thus, to make an important farmland inventory we need soil survey, land use, and socio-economic data.

During 1976, two significant policies for rural lands were issued that will support the soil survey and the important farmland inventory effort. USDA has developed a policy to advocate the protection of prime Lands from premature or unnecessary conversion to other uses, especially those prime lands threatened by conversion to irreversible land uses. Secondly, the Council on Environmental Quality (CEQ) has recognized prime and unique farmland as an important part of our national heritage. They have interpreted existing policy to preserve an environment which supports diversity and variety of individual choice to include highly productive farmlands. As a result, all federal agencies are to assess the effects of their proposed actions in regard to prime and unique farmlands.

Most gratifying is the awareness of the general public, local officials, and state legislators that there are indeed differences in land quality and that the most productive soils need to be retained for agriculture. Since major criteria for defining prime and other important farmlands are based primarily on soil surveys, these significant actions and attitudes will strongly benefit soil survey. For example, New York has recently passed legislation to provide funds for soil surveys, to, and I quote, “accelerate the inventory of prime lands.”

Plans are to complete nearly 1300 high priority important farmland inventories by 1981 and monitor them every 5 years to determine changes in use.

I selected the important farmland inventory for discussion to emphasize how much soil surveys are needed for our overall land inventory and monitoring program. Soil surveys with interpretations are powerful tools in land use planning; but where combined with other natural, social and economic resource data they become even more useful and meaningful to those that must make land use planning and policy decisions. It is this latter point that sets the role of the land inventory and monitoring program apart from the soil survey program. It also shows their mutual supportiveness.

Your efforts to accelerate soil survey mapping, step up publication rates, and improve interpretations are demanding of your staff and soil scientists’ time. Yet, there is clear evidence that the role of the soil scientist will continue to expand in the years ahead. As we proceed to develop and implement inventory and monitoring activities, your support is needed. Let me list some of the opportunities that I see for the immediate future.

1. We should work together to assure that a suite of controlled base maps are available for soil survey and other essential inventories. The use of orthophoto base sheets for soil survey will greatly aid in sampling techniques and future digitizing of soil surveys. We need financial support for the cost-sharing program with USGS to produce intermediate scale maps at scales of 1:50,000 and 1:100,000. In addition to their use for generalized soil maps and interpretations and the inventory of important farmlands, they can be used for river basin studies, RC&D projects, watershed projects, and other maps for conservation operations and related activities.

   Other agencies, too, are involved in the use of these controlled base maps. BLM has ordered a large number in the Western States in a quadrangle format, The Fish and Wildlife Service is planning their use wetland inventories and USGS will use the base to display land use formation. The Topographic Division, USGS, has received OMB approval of their FY 1978 budget. It includes the full amount requested for the cost-share intermediate scale base map program based on the projected needs of SCS, BLM, and others.

2. Every soil survey completed and published makes our job easier. However, some of the surveys identified as completed do not have a soil survey of the urban areas. These are needed.

   Soil surveys need to be updated on the Conservation Needs Inventory statistical sample sites. These sites or a subset of these sites were used for several inventories and studies. Might the same 2 percent sample we need to obtain reliable county resource data be used in a followup program for soil survey that would tell you when a completed soil survey should be recorrelated, reinterpreted, or remapped? This might be considered an extension of your sampling procedure to validate quality of map compilation. How might this work? Well, a simple form completed by a district conservationist might provide the test for adequacy of interpretations. Soil scientists monitoring the sample sites might signal the need for updating correlation or remapping If this was adopted as a continuing activity, both programs should benefit and the impact on soil scientists' time would be minimal for any one year.

3. Tremendous progress has been made in soil survey interpretations. You are developing a more positive approaceh for presenting soil behavior predictions with soil potentials. In doing so we cannot overlook those interpretations that others have used and will continue to use for their programs.

   The national study of prime farmland strongly suggests that the agricultural land capability classification system is not adequately correlated in some parts of the U.S. For example, some states indicate that a part of their Class VI soils were prime farmland. we feel that upgrading the system should be given high priority in soil survey.

Many states have laws requiring the use of soil surveys for tax assessment of agricultural land. Some are based on agricultural capability classes and others on the productivity indexes. For environmental impact statements, data on the productivity and invironmental tradeoffs of substituting prime lands for other lands are needed.

We urge, as a first step, that national guidelines be developed for preparing productivity indexes so that this needed information can be added to the soil interpretations.

4. We should cooperate to cost-share the task of digitizing all of the 900 plus soil surveys that are completed. Nap separations are needed for nearly every one of these surveys if they are to be digitized automatically. This task must be done unless we contract to hand digitize these surveys, a costly effort.

   To show our interest, we have made arrangements with the Cartographic Division to digitize 18 soil survey areas. Host of these also required us to contract for map separations. When this is done we will have firm data on costs and time.

   We urge that strategies be developed soon to digitize all completed surveys and future soil surveys.

Finably, let me say that soil survey information is the first important key to an understanding of our environment. If we are bold enough to move forward to inventory other related resources and proceed to interpret the interrelationships, we can truly provide the tools needed for conservation planning, resource use and development, community development, and environmental improvement.

Soil Classification and Correlation

John E. McClelland
Director, Soil Classification and Correlation, SCS

During the past several years we have accelerated our soil survey program for the most part by contributions in both money and personnel from other agencies and units of government. It is our goal to have modern published soil surveys for the nation by the end of the century. The Soil Classification and Correlation portion of the program is being accelerated by increased responsibilities at the state and technical service centers as well as by increased cooperator inputs.

On July 1, 1976 there were 1382 soil scientists in the SCS of which 22 were in the Washington Office, 47 at the technical service centers and the laboratories, 169 in state offices, and 1154 in the field. In addition about 41 technicians support the soil survey program. In the cooperative effort federal cooperators have 160 soil scientists, and there are about 450 soil scientists employed using nonfederal funds.

Since our last meeting, Soil Taxonomy has been published. We are now working on improving it. Several proposals for amendments are being considered, many of which concern subgroups that are provided for but without complete definitions.

The revision of the Soil Survey Manual is continuing. We hope to have a final revised draft circulated by the end of 1977 and will publish it as soon as comments are received and editing is completed. We are continuing to have revised portions reviewed by cooperators.

The National Soils Handbook is gradually being developed. When completed it will replace the soil survey memorandum series. For some parts of the handbook, drafts have been circulated and comments incorporated into them. Some of these are now in effect. Much of the rest of the handbook is being circulated for review or is being prepared. The National Soils Handbook deals with policy and its application or the application of procedures that will change from time to time. The Soil Survey Manual spells out basic procedures for making soil surveys anywhere. It is a popular book and has been reprinted every few years.

The National Soils Handbook is being printed in loose leaf form. In this form amendments can be inserted easily and new sections added. It is intended that all cooperators in the national cooperative soil survey will receive copies.

SOIL SURVEY INTERPRETATIONS DIVISION

Donald E.McCormack
Director, Soil Survey Interpretations Division

This Division is concerned with the application and use of soil surveys. It is apparent that this conference is giving increasing attention to this subject. Major activities of the division will include implementing the soil potential concept, establishing a systematic collection of soil performance data, soil interpretations for minimum tillage and waste disposal, and continued study of improved procedures for the publication of soil surveys.

Soil potentials provide a vehicle for presenting more fully what is known about soils than soil limitations or any other approach now used. They permit us to get around the negative, nonuse aspects of soil limitations resulting from the tendency to assume that soils having severe limitations could not be used. Soil potentials represent in a positive sense the quality or suitability of soils when feasible modern technologies are used in maximize performance. Performance or production levels that car. be achieved using such technologies and the costs of these practices are part of the process of developing soil potentials. Also included is the identification of continuing limitations or maintenance problems after feasible practices are applied.

We intend to take the actions necessary to institute soil potentials in the near future. We have been discussing and debating the issues long enough, and it is time to proceed. A Washington office committee representing affected disciplines is developing a policy statement and a very general set of guidelines.

A systematic procedure for recording soil performance is required to support the soil potential procedure. Actually it has always been necessary in order to verify soil interpretations, but we have never established the methodologies for a nationwide system except for the soil-woodland and soil-range site studies. An attempt was made 2 or 3 years ago to institute such a system. The proposal was favorably received, with many comments to the effect that it has been badly needed for a long time. On the other hand, many states commented that a great deal of effort would be required and that the staffs were already overloaded. We will attempt to institute procedures that can be followed in states at a pace they consider appropriate.

We have been vary late in developing adequate soil interpretations for minimum tillage, especially no-till. It is apparent that the success of no-till for corn and other crops is dependent on soil properties and we need a concerted effort to develop appropriate soil interpretations. We also want to study carefully the soil interpretations that we should be making for disposal of various kinds of wastes in soils. We solicit your proposals in both of these areas.

The Division will continue the example set by Dr. Bartelli in developing new procedures to facilitate the publication of soil surveys. As a result of the acceleration of publications made possible by new procedures, the time between the completion of mapping and publication is progressively being reduced. A review in 1973 indicated that the time lag averaged 5.5 years then. Recent projections indicate that the lag will be down to 3 years in FY 1978 and about 2 years in FY 1979.

Soil Survey Investigations Division

Raymond B. Daniels
Director, Soil Survey Investigations Division

The transfer of Soil Survey Investigation Specialists to the Technical Service Center will be completed by July, 1977. Many details of the kind of work these specialists will be doing needs to be worked out with the Directors of the Service Centers. Some of the men have 15 to 20 years experience in field research and we do not want them doing work that can be handled by less experienced individuals.

If the present plans of the Soil Conservation Service and the individuals in the field phases of Soil Survey Investigations are not changed, we will have only two experienced field men in the field field positions by July, 1977. One of our major projects is to find and employ qualified field men for these positions. It is preferred that the individuals filling these positions have academic training through the Ph.D. level.

Soil Survey Operations Division

Donald E. McCormack
Acting Director, Soil Survey Operations Division

The principle function of this Division deals with the management of soil surveys. Work planning, scheduling, inspections, techniques, and budgeting are major activities. Through these activities, we attempt to maximize the resources available for making soil surveys and to get the most out of the resources available.

We are giving emphasis to identifying the needs of the soil survey for funds and personnel, preparing careful justifications, and following through so that these needs are properly expressed in the budget proposals of SCS and USDA. Success in these efforts will assure continuing support for completion of the soil survey of the nation.

Currently being studied is a revision in the content of soil survey work plans. This study will consider the need for careful evaluations of the objectives of each soil survey to serve as a basis for certain specifications that must be established prior to the start of the survey, especially the scale and the minimum size of delineations of contrasting soils. We believe it is appropriate for these objectives to be stated in rather specific terms in soil survey work plans. Also, the minimum size of delineations should also be specified. We would welcome your proposals for other revisions that should be included.

The outlines and formats for soil survey inspections (formerly appraisals) of states will be reconsidered. It appears that they may interfere in some ways with a thorough evaluation of means to improve soil surveys in states, which should be the main purpose of the inspections. Sufficient flexibility should be available so that there is time to consider in depth those issues of key importance.

The Division works closely with the scheduling of soil surveys for publication and maintaining accurate dates in the CASPUSS schedule. One of the challenges is to schedule the completion of soil surveys so that the text and the maps are ready for publication at about the same time. We are steadily improving this coordination. Beginning in FY 1978, we intend to release to the field a schedule for the publication of soil surveys that indicates those surveys that will actually be published. in the fiscal year. Unfortunately, it has never before been possible to do this. Our so-called soil survey publication schedule has heretofore been misleading as it was a list of those surveys for which the text manuscript would be sent to GPO during the fiscal year. Many of the surveys listed were not published within two years of the time the text was submitted to GPO.

Soil mapping is now completed in Hawaii, Puerto Rico, Maryland, and Delaware, and is nearing completion in several other states. As states are completed, we intend to shift funds and personnel to other states where the work is not so far advanced. If this is not done the overall effort nationwide will gradually decrease. We are developing guidelines for analyses of workloads and staffing of soil scientists in states and administrative after field mapping is completed. The soil science discipline must continue to be properly represented in SCS activities.

TECHNICAL COMMITTEE REPORTS

WORK PLANNING CONFERENCE OF THE
RATIONAL COOPERATIVE SOIL SURVEY

January 30 - February 4, 1977

Orlando, Florida

Committee Number 1 - Modernizing Soil Surveys

Charges:

1. Evaluate the magnitude of the problem and explore economical means for upgrading published soil surveys.

2. Develop and/or cause to be developed, and assemble models for soil formation and other sections of published soil surveys that can be fed into Linolex systems for modular writing. Models should also include sections dealing with both farm and nonfarm soil potential discussions, and soil treatment of wastes and other environmental impacts of soil use.

3. Identify methods for applying graphic and tabular display systems to soil survey interpretations.

4. Develop formats for soil survey text manuscripts for use in the publication of soil surveys of different Orders (I-V). This could be done to meet the specific objectives where one land use predominates, or by Land Resource Areas.

Introduction:

Four subcommittees were established to handle each of the above charges. Committee work was done largely by correspondence. Reports were written and circulated to participants. The chairman prepared a preliminary overall report from material submitted by the subcommittee chairman. These reports and recommendations were reviewed and amended at this Work Planning Conference. The summary of recommendations is followed by a discussion from the floor.

Recommendations:

A. Upgrade Published Surveys.

1. Adopt the following four category definitions for upgrading published soil surveys.

a. Category 1.

(1) Mapping units (delineations) are not adequate by today's standards.

(2) The mapping units cannot be interpreted to meet current needs. The surveys that fall in this category require a new complete survey.

b. category 2.

(1) Mapping units (delineations) are adequate but are not on a photographic background.

(2) The napping units can be interpreted to meet current needs

In this category the soil lines would be transferred to a new photographic base by a soil scientist who is familiar with the area. With some field checking the soil maps can be prepared in a' fraction of the time required to remap the area. The names of the map units in the "old" survey could be used and soil interpretations selected that match the old napping units. Recorrelation and use of new map unit names may be preferred in many surveys. Publish a supplemental soil report containing new revised soil maps, text, and tables.

c. Category 3.

(1) Most mapping units are adequate but some are inadequate by today's standards.

(2) Most mapping units can be interpreted but some need remapping to interpret for current needs.

The surveys in this category include areas that were mapped on a broad scale. Thus, some mapping units may include such an array of soils that they cannot be interpreted for current user needs. If the land use in these areas is changing and large areas are involved, consideration should be given to supplementing the mapping and amending the correlation. A supplemental report would be published containing the maps of that part on which supplemental mapping was done, updated interpretations and any new interpretations that were needed.

d. Category 4.

(1) Mapping units are adequate by today's standards.

(2) The mapping units can be interpreted to meet current needs.

Use the soil map and mapping units as published and upgrade the survey by upgrading the interpretations and issuing a supplemental soil report.

2. Develop procedures for evaluating a published soil survey as to upgrading needs and make these a part of the National Soils Handbook.

3. Consider upgrading needs along with orginal field work when setting annual priorities at state and national levels.

B. Modular Writing.

1. Charge regional committees to develop soil formation section models for one land resource or geographic area in each Land Resource Region.

C. Display System.

1. The Resource and Management Information System (RAMIS) Task Force be asked to explore the possibility of a computerized data file as the principal repository for soil data. The RAMIS Task Force is currently examining SCS's data needs.

2. Encourage states to take action to assure that local planning for soil surveys involves major potential users and that all surveys include interpretations to meet foreseeable needs.

3. The number of figures in a published soil survey be related to their quality and effectiveness rather than an arbitrary limited number.

4. Soil Conservation Service prepare a soil graphics notebook of examples and approximate costs to be distributed to each state.

D. Manuscript Format for Soil Survey Orders.

1. Permit maximum flexibility in manuscript form and content by using existing formats as examples with variations justified by needs of users. Use tables related to expected needs of users whether generated by the computer or not.

2. Discontinue charge Number 4 of Committee Number 1.

E. Other Recommendations.

1. The committee "Modernizing Soil Surveys" be continued.

Discussion and Comments:

Committee 1.

Flach - We need national guidelines for upgrading soil surveys.

Rourke - We want regional input into these guidelines.

Flach - Okay to get regional input, then coordinate at national level before states start to evaluate a survey for upgrading.

Naphan - Develop guidelines on national level, then send out for comments.

McCormack - Ten year8 ago, there was a study to make use of older surveys. Refer to this.

Flach - The gray area is between "survey adequate" and "survey not adequate."

Whiteside - Don't downgrade some of the old surveys. Look at these old surveys objectively.

Fenton - Let feedback from users guide us. This is what Iowa is doing in deciding whether to remap.

Cuthbertson - Ask the user whether the survey is adequate.

Gockowski - Can we live with the lines being off when transferring line maps to a photobase?

Whiteside - Experience shows the lines "fit remarkably well." Warn the users that the lines are off a little.

Fuchs - Techniques of determining survey adequacy will need to be variable by categories.

Flach - We will. be forced to look at all the surveys. If recorrelation is needed, it should be done.

Dement - Don't wait until the end of survey work. We should be doing this now.

Nichols - Test these four categories on the old TVA surveys.

Flach - Put this in the committee report.

Flach - We are concerned about moving personnel. Don't transfer knowledgeable people until the recorrelation is completed.

Wilding - Okay. As long as we don't delay their promotion.

Flach - Priority of needs should be considered. (Remapping vs new mapping.)

McCormack - Use ADP to do the task of renaming mapping units.

Stout - Use the mapping unit use file in upgrading interpretations in old surveys.

Wilding - We may not be able to establish the composition of some napping units without going back to recheck mapping. We need to design techniques to fit the survey. (Example: Different for Order V survey than Order II)

Dideriksen - Evaluating the old surveys can serve several needs if we design the procedure properly.

Whiteside - We average 3 man months of' field time in renaming and describing soils in an average survey upgrade.

Martin - Setting priorities should not be done just by SCS and not just by soil scientists. Be sure there is total input, from user through the top administrators.

Subcommittee 1B.

Flach - After you get the first couple of models, the rest would go quickly. Why not develop models for all Land Resource Areas?

Fuchs - Too many resource areas to ask regional committees to prepare one for each.

Touchet - Why not by Land Resource Regions? Do a representaive resource area for each of these regions.

Subcommittee 1C.

McClelland - If soil scientists were better writers, we would have fewer problems.

McCormack - There is a limit to how much we can innovate and still retain the benefits of automation. Leaving format open leads to problem with material in manuscripts. We don't want to cut off new ideas, though.

Fenton - IA work plans, agree to a format that will not change during the survey.

Fuchs - This committee did not consider a writing format as much as display.

Grossman - Are people in Extension involved with this?

Owens - Use of visual aids to explain the survey might be better.

Flach - Might cut the publication to the bare bone and rely more on local publications.

Owens - Might consider having more people from the Extension Service on these committees.

Rust - When will we stop printing soil surveys? With computers we have the capability to produce many displays. We must be able to serve the users.

Flach - We are concerned about the cost of publications.

R. Johnson - Cut to the minimum the number of publications, but publish a cookbook of what could be generated and let the user tell us what he wants and let him pay for it.

Flach - Laws require that we make surveys and publish them.

McClelland - If you don't publish, how will the general public get this information?

Flach - Extra copies don't cost much, except storage charges.

R. Johnson - We don't need more studies on format. Recently we had a Task Force which related in part to users needs and now we are back at the old stereotype.

Subcommittee 1D.

Link - Did the committee consider the format of the published soil survey or formats of certain sections?

Dirking - Formats for sections in different order surveys.

Naphan - Present models adopted for Orders I and II surveys are inadequate for Orders III, IV and V. The use of these models is complicated when you have a mixture of different orders in one survey.

Wilding - Computers are good for canned introductions, etc. By doing this for all parts of a soil survey, we are removing the opportunity of a soil scientist to write. This is going to make the survey technically sterile. Parts of the manuscript should be handwritten.

It was moved and seconded that the conference accept Committee 1 report as amended. The motion carried.

Recorder: J. C. Powell

Committee Members

B. T. Birdwell
*E. J. Ciolkosz - Vice Chairman
*I. D. Cuthbertson
*W. W. Fuchs - Chairman
R. H. Gilbert
R. O. Googins
G. L. Decker
C. G. Johnson
'R. W. Johnson
*D. E. McCormack - Advisor

*E. A. Naphan
*W. D. Nettleton
F. F. Peterson
'J. C. Powell
*Marvin Meier
G. H. Simonson
R. M. Smith
E. E. voss
D. S. Way
*J. M. Williams
K. K. Young

*Attendance at conference

NATIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

January 31 - February 4, 1977
Orlando, Florida

Committee #2 - Improving Soil Survey Techniques

CHARGES

1. Explore ways of improving field mapping operations, legend design and soil mapping to increase efficiency and accuracy. Study the job of updating late "line-map" surveys with remote sensing techniques and a minimum of field work.

2. Identify problems related to soil survey techniques and formulate plans to solve.

3. Summarize activities of working groups of International Society of Soil Science on soil information systems and on applications of remote sensing for work planning conference.

4. Explore ways for using ADP in correlation process.

Charge No. 1

The committee was split as to the value of attempting to update late "line-map" surveys with or without using remote sensing techniques. Factual information about experience using remote sensing techniques for updating did not come to the attention of the committee. Comments regarding the value of updating ranged from:

--we are ahead if we redo the entire survey,

--useful and reduce the amount of field work needed to remap,

--we should recognize their value and utilize them if remapping is not essential,

--have value and can be updated at much lower cost than complete remapping.

Some late line-map surveys are being completely remapped, others are being updated using various techniques.

Published line-map soil surveys have at least two significant differences from "modern" soil surveys. They lack a photographic base and do not contain modern up-to-date soil interpretations (generally, they have only agricultural related interpretations). In addition, they may or may not have other qualities generally attributed to more modern surveys, such as, the design of mapping units to meet present needs and descriptions adequate to recorrelate soils for updating interpretations. It seems obvious that whenever valid questions are raised about the adequacy of line-map surveys to meet present needs, these surveys should be evaluated before a decision is made to remap. Even if the final decision is to remap, the evaluation furnishes information that will have use for accelerating field operations and attaining product quality of the new survey. The major item then becomes, what procedures can be used to determine the "quality" of the survey and its adequacy for present needs?

It should not be assumed that all line-map surveys do not adequately delineate soil areas for present needs. This characteristic of the map should be evaluated if there is a reasonable possibility they are suitable or can be made suitable with less input than complete remapping. The inputs required may vary and each survey should be individually evaluated. Many of the later line-map surveys used aerial photos for field sheets. These should be obtained for use during the evaluation.

Factors that should be considered when evaluating line-map surveys for updating or remapping include the following:

1. Identify the present needs and projected future uses of the soil survey information. Some purposes may have significantly changed since the survey was made. Evaluations of line-map surveys cannot be effectively made unless current needs are fully identified. If it is subsequently determined that complete resurveying is not needed, the evaluation will identify where some adjustments may be required.

2. Evaluate the line-map survey qualities for meeting these current needs. Identify specific suitabilities as well as deficiencies. Some important considerations are:

   a) The concepts of the taxonomic soil units of line-map surveys were based on a different system of soil classification than the current Soil Taxonomy. The ranges of all soil properties of the taxonomic units may not precisely conform to classes in the present system but those that are important for needed interpretations may be adequate.

   b) Composition of mapping units and consistency between delineations of mapping units should also be evaluated. It may be that only certain areas of the previous survey are not adequate for present needs. A procedure used in Michigan to characterize mapping unit composition is described in Attachment No. 1. It should be noted that the Michigan procedure assumes the original mapping unit design is still adequate and that reasonable quality control was exercised throughout the survey.

c) The cultural map detail should be analyzed to determine if it is sufficient for accurately locating specific areas on the map. If lack of base map detail is the major or only deficiency, evaluate alternatives for updating the base.

d) Some line-map surveys have adequate soil delineations and descriptions but lack slope phases essential for present uses. Slope maps can be obtained for 7 1/2-minute quads that are very useful for characterizing slope properties. The slope maps can be scaled to match the base map scale for analyzing soil-map unit slope relationships and transferring data.

e) To evaluate line-map surveys, some systematic method of sampling that will yield reasonably reliable documented data is essential. A common transecting technique that has been used and found useful is Attachment No. 2 of this report. Various physical characteristics of a survey area may be such that one method of transecting may be more practical than others. The intensity of application of transecting procedures should be sufficient to characterize the nature of the mapping unit consistent with NCSS standards for correlation and intended soil interpretations.

3. If the evaluation of the line-map survey indicates that the mapping units are adequate for current needs, then decisions can be made concerning:

   a) Need for republishing the soil survey after upgrading the names and descriptions to current standards.

   b) Supplementing present publication.

   c) Developing specifications for a new soil map base, if this is needed.

   d) Additional field studies needed to upgrade soil information to meet current needs.

Charge No. 1 Recommendations

1. Line-map surveys should be evaluated for meeting present needs before a firm decision is made to completely remap the area. It should be documented that remapping will furnish a significant improvement of soil information for present and anticipated needs.

2. Guidelines and procedures for evaluating and updating line-map surveys are needed and should be included in the National Soils Handbook.

Charge No. 2

Various comments were received related to the attainment of "quality control" in soil surveys. They were rather general and related to achieving better quality of field notes, taxonomic descriptions, mapping unit descriptions, legend design, interpretations, understanding of soil-landscape relationships, use of existing data and experience, photo imagery (or map base), and identification of purposes for making the survey. It appears that most of these are not universal problems, but ones that develop periodically through normal operations.

The NCSS quality standards for most of these items and the procedures for attaining them are given in the National Soils Handbook and the Soil Survey Manual. It does not seem appropriate to repeat in detail in this committee report the material from the Handbook. It is recognized that these are important elements of a soil survey and they need continued attention to.obtain good quality.

In regards to comments concerning general improvement in the quality of field data, the need for training to soil scientists in the principles of soil-geomorphology relationships has been identified. Soil scientists who at one time received good onsite training from soil-geomorphology study groups are becoming fewer. Many present soil scientists began their career after training sessions at the soil-geomorphology study areas ceased or for other reasons did not receive this training. As a result, few have had the opportunity to improve their knowledge and skills in this field. It is recognized that an understanding of the principles of soil-geomorphology relationships and their application is essential for efficiently making and interpreting soil surveys.

Various methods of transecting and statistical analysis of sample data have been used in soil survey activities. Transect sampling and analysis have been applied: a) at the initiation of a survey to aid in mapping unit and legend design, b) during the survey to study existing mapping units and the possible need for new mapping units, and c) at the end of a survey to evaluate mapping units and consistency throughout the survey.

Many studies have been made of survey areas using transect methods and statistical analysis of the data to estimate the nature of the taxonomic soil unit and the composition of the mapping unit. Often the "quality" of a soil survey is indicated by the percent of the mapping unit that is within the class limits of the taxonomic unit that is used for identification. This has some validity if the taxonomic classes are near perfect for defining kinds of soil for the various purposes for which surveys are made. The evaluation using precisely defined.classes of.Soil Taxonomy can indicate how accurately the soils were mapped in this respect. From the use perspective, a more realistic evaluation would determine the uniformity of the soil properties that effect use and management for the purposes of the survey. This is the kind of evaluation that will be needed by most of the users. Transect data should include the percent composition of the mapping unit that is within the taxonomic class and the percent of soils that have the same or very similar use and management requirements for the purposes of the survey.

Several different transecting methods have been used in soil surveys. A common one used is Attachment No. 2 of this report. Other methods have been presented in scientific journals and other technical articles and some not yet published. A comprehensive review of the many methods is not part of this report.

"Poor quality" panchromatic aerial photography for field soil mapping continues to be identified as a problem. Nearly all comments are rather general in nature and without specific details. Where some details are identified, they are usually related to poor contrast and lack of sharpness.

These deficiencies may originate with the contractor and involve quality control in the processing phase. The SCS cartographic unit is continuing efforts to overcome these problems. More direct relations with the contractors are resulting in some increase in quality. However, not all imagery problems can be easily overcome. Poor air quality is not generally decreasing. Recently, accepted photography is of somewhat better quality.

After October 1, 1977, all SCS contracting for new aerial photography will be done through the Agricultural Stabilization and Conservation Service. Within USDA regulations, standards and specifications for soil survey needs will be met.

The uniform application of soil moisture regimes, particularly the drier ones, have presented some problems. Few soil moisture measurements have been made to evaluate the present criteria for Aridic (Torric), Ustic, and Xeric moisture regimes. The SCS has a CCOBOL program of a model written to calculate from climatic data the moisture regime according to the definitions of Soil Taxonomy. The output of this model is useful as one element of several to help estimate soil moisture regimes. It needs additional testing and verification with actual soil measurements. Plans are being developed to accomplish additional testing and modification, if needed. Soil moisture measurements from moisture control sections along with precipitation data are needed.

Charge No. 2 Recommendations

1. Soil scientist training in the principles of soil-geomorphology relationships and their application to soil mapping should be strengthened.

2. Guidelines for using transecting procedures and data analysis for evaluating the nature and composition of mapping units of soil surveys of different intensities need to be included in the National Soils Handbook.

3. Additional soil moisture data should be collected and present guidelines evaluated in an effort to improve application of Aridic (and Torric), Ustic, and Xeric soil moisture regimes.

4. High-quality aerial photo imagery is essential for optimum quality and quantity of soil mapping. All possible alternatives should be evaluated and reasonable ones used to ensure the best quality photos are obtained for field soil mapping operations.

Charge No. 3

As the scope of applications of soil data increases, there is a growing need for soil information systems to process the large volume of data. The need is not only to process soil information directly, but to be able to interface it with other related environmental data. Worldwide, many kinds of soil information systems are being developed and evaluated. They range in nature from basic soil data record files to automated cartography producing interpretive maps. An excellent review of soil information systems is in Proceedings of the Meeting of the International Society of Soil Science Working Group on Soil Infonnations Systems, Wageningen, The Netherlands, September 1-4, 1975. The proceedings are published by the Center for Agricultural Publishing and Documentation, Wageningen, The Netherlands, 1975. A symposium on Resource Informations Systems is planned for the 11th International Congress of the ISSS, Edmonton, Canada, June 19-27, 1978.

Progress on the SCS Advance Mapping System continues. Although some problems still exist, they are being resolved and the outlook for the future looks good. This system is designed to accept data from a soil survey map and process it and produce various soil interpretive maps. It is planned for the system to be operational this year.

An optical mark reader system for reading forms marked to record pedon description information is functional. The programs for interpreting mark forms are in the final testing stage. This system has been developed to write pedon descriptions with the aid of a computer.

Uses for which the mark-sense coding can be applied include:

1. The use of mark-coding forms for taking notes of soil reactions and observations in the field.

2. The use of mark-coding forms for recording the collection of samples for laboratory analyses.

3. The revision of the SCS-SOILS-10 forms from a card-punching system to a mark-sensing system.

Engineering test data for selectively sampled soils are now being processed by a large computer and outputted on magnetic tape. The format is set up by a word processor in final camera-ready copy suitable for publication in a soil survey.

Development of the programs for complete processing of physical and chemical laboratory data is progressing. This subsystem will permit the direct inputting of laboratory data with the output in narrative and tabular form ready for publication.

Investigations into the application of remote sensing techniques for resource inventorying continue over a broad spectrum. Most of these activities are related to broader uses than applicable to the majority of soil surveys. Land satellite and similar imagery cannot provide the resolution required for most soil mapping needs. While some resource data needs can only be satisfied by LANDSAT data, the greatest percentage can be met by high resolution black and white photography from aircraft.

Active multispectral radar imagery is a relatively new field. It has considerable potential for earth observation studies. Some capabilities of active multispectral radar that have potential for soil surveys include:

1. Evaluating soil moisture by detecting plant water deficiencies.

2. Detect soil moisture content (upper 15-20 cm).

3. From space altitudes, radar can obtain stereoscopic imagery.

4. Penetrates darkness and clouds.

5. Long wave length radar (some where greater than 3 cm) can penetrate vegetation and soils to 15 to 20 an.

The SCS has a three-man interdisciplinary group in Reston, Virginia, to evaluate and test advance remote sensing technology and its application to SCS activities. In a recent in-Service report, they state that remote sensing technology has been tried and:

a. looks promising - examples

1) Color infrared imagery has proved to be cost-effective in speeding up soil surveys in areas with native vegetation. Soils in the area need to have contrasting water holding capacity and imagery needs to be taken when some of the area is under moisture stress for maximum benefits.

2) High resolution black and white imagery from aircraft at appropriate scales will satisfy most needs.

3) Orthophoto maps - provide excellent base maps for mapping soils and for published soil surveys. They are free of distortion and objects are in true position on landscape. These maps save money and time in compiling completed soil surveys. They also have similar advantages if the soil survey on this base is to be digitized.

4) Using several types of imagery at the same time, can be more cost-effective for use in resource surveys than using any one of the types by itself.

5) LANDSAT imagery and multispectral data has proved cost-effective for reconnaissance soil surveys.

6) Conclusion reached in the Hildage County, Texas, project that evaluated various kinds of imagery for soil mapping use was that color infrared and color photography were valuable tools for mapping soils.

b. limited or no value - examples

1) LANDSAT imagery and multispectral data lack sufficient resolution for soil surveys of the Order 1 and Order 2 level of detail (detailed soil surveys).

2) Color infrared imagery is of limited value for soil surveys in areas that are irrigated.

Minnesota recently evaluated soil mapping techniques using panchromatic, black and white infrared, and color infrared. A preliminary report of this evaluation is Attachment No. 3. It is also noteworthy that color-infrared photography can substantially improve the probability of obtaining good-quality imagery during the flying season. This results from the fact that color infrared can record images through more haze than can panchromatic film. The Minnesota studies indicate that although the original cost is slightly higher, the value returned through higher quality surveys and increased production more than offsets the higher costs. The special imagery was acquired by the University of Minnesota.

At the last conference (1975), it was requested that the possible declassification of some technology could possibly furnish potentially valuable material. This possibility was studied and it's reported that in general classified and nonclassified material satisfies the same type of requirements. Classified material has many of the same limitations as conventional aerial photography currently available for USDA use. Moreover, as long as present security restrictions remain enforced, it is difficult and costly to use.

Charge No. 3 Recommendations

1. More effective coordination and distribution of information about the direct application of non-panchromatic imagery in making and interpreting soil surveys are needed. Regional committees have given this some emphasis. This emphasis should continue. Soil Survey Technical Notes offer an excellent opportunity to distribute results of evaluations of material and techniques.

2. Utilizing the experience gained in Minnesota, the application of color infrared photography to soil mapping should be tested in other states.

Charge No. 4

SCS-SOILS-6 form (copy attached) designed primarily to recall soil interpretive material on SCS-SOILS-5 form has potential for other applications as well. If SCS-SOILS-6 forms are used from early in the survey work and well maintained during the survey, they can be used to obtain from the Ames, Iowa, Computer Center, a field correlation document. This document would contain the recommended mapping unit names and symbols along with other symbols used but dropped during the survey. If the final correlation is the same as the field correlation, the same format can be designated as the final correlation. Little use has been made of this procedure mainly because of the turnaround time.

Another application of the SCS-SOILS-6 form that has attained limited use is for input data for a mapping unit use file. The Soil Classification and Mapping Branch at Hyattsville is working on programming this record file. There are many possibilities for formatting the output and anyone who has a need for this data should let their needs be known. One of the major problems related to the mapping unit use file concerns the fact that mapping units are not correlated to a national system. Although the taxonomic units used to identify mapping units are correlated to the System of Soil Taxonomy, mapping unit names are not correlated.

No other comments or suggestions for ADP use in the correlation processes were received.

Charge No. 4 Recommendations

1. Potential uses of ADP in the soil correlation process should continue to be studied and evaluated.

2. Development of the mapping unit use file should continue.

General Recommendations

1. The committee on Improving Soil Survey Techniques should be continued.

2. The report of this committee should be accepted by the conference.

Both general recommendations were accepted by the conference.

Chairman - V. G. Link*
Vice Chairman - E. P. Whiteside*

Members:

J. M. Allen
O. O. Bockes
R. B. Daniels*
R. A. Dierking*
T. E. Fenton*
R. H. Gilbert
P. R. Johnson
C. A. McGrew
F. T. Miller
J. D. Rourke*
F. M. Scilley*
C. A. Steers
G. W. TeSelle
J. A. Thompson*
B. G. Watson
L. P. Wilding*

Advisors: D. E. McCormack* and J. A. Gockowski*

* Members in attendance

Notes concerning updating and quality control of soil surveys in Michigan

E.P. Whitesida

In the past five years soil survey personnel of the Michigan Agricultural Experiment Station and some other scientists in the National Cooperative Soil Survey, have made a number of studies of the composition of map units on current and older published soil surveys in Michigan. Cur general conclusion is that an independent sampling of the map units is necessary to adequately characterize their compositions after completion of the field sheets in order to evaluate the adequacy of the map units, their names and their descriptions for current uses of the soil surveys. Here I have summarized the results of those studies for consideration of Committees 1 and 2 of the 1977, WPC-NCSS.

These studies assume that the usual quality control techniques in setting up the map units and properly coordinating the work of party members have been satisfactorily applied to the completed field sheets or published maps being evaluated. These are essential prior conditions for adequate surveys. Their fulfillment involves continuing efforts and eternal vigilance of party chiefs, working with new personnel and our evolving understanding of soil-landscape relationships. In general, however, we feel that the correlation procedures in use by the National Cooperative Soil Survey have been reasonably satisfactory since 1920. Of course numerous improvements in techniques, base maps and mapping aids have been introduced since that time. Aerial photography was one of those improvements introduced in the mid-thirties. However, the plane table surveys or topographic sheet bases of earlier surveys have proved to be very adequate in most cases studied to date (including the 1926 Tuscola County soil map).

Basically the techniques in sampling the map units have been soil observations at points, or points on line transects on the landscape, selected systematically to represent the area or the map units included in a soil survey without introducing biases in the samples. A sample of et Least 30 to 50 points in each map unit or 50 to 100 points in a survey area have been considered adequate as judged by agreement of successive samplings of similar size or Larger size.

Table L shows the results of the studies to date in the then current soil surveys or older surveys being evaluated. The independent sample soil observations are compared with the map unit names as to series, surface texture, slope class or erosion class and the soil management groups (of similar soil series) represented by the series in the names of the map units.

It is evident from these data that the surface textures, slope classes and erosion classes, where tested, agreed 64 to 98% with the names of the map units. The soil series and soil management groups agreed 52 to 62% and 62 to 71%, respectively, with the map unit names -- both in the current surveys (1973, in

Clinton, Washtenaw and Wayne Cos.) and in the older surveys with the updated map legends. The Eaton County survey showed least agreement with series names of the map units and their soil management group.

A sample of 50 observations in Newaygo County after updating showed 66% agreement with the series and soil management groups of the updated map unit names -- while the over 1500 observations made in updating the map legend showed 53 and 61% agreement, respectively. Perhaps observations at 50 points were not sufficient to provide a good evaluation. Some people feel that eve" 78 observations in Eaton County are inadequate. It seems that a sample of 100 points or 150 points might be better. If these were coordinated into three sets of 50 observations distributed over the area the values with 50, 100 and 150 could be compared.

I" Table 2 the percentages of each county in map units with one, two, three or contrasting series in their updated names are shown compared to the names of map units in two more recently completed soil surveys. Independent evaluations of the legends in Muskegon and St. Clair Counties have not been made since their completion but they were made and published on aerial photographs.

It is evident that while there are smaller percentages of the map units in older surveys with updated legends, that have only one series name, most of them have only 2 series in their names. Some of those older surveys have little of their area in map units with contrasting series in their updated names. Whether it is feasible to reduce the proportions of those units with contrasting names needs separate study.

Our conclusion here is that many of the soil surveys completed in Michigan still have considerable utility for farmland evaluation and more general planning purposes. Updating the names and descriptive legends of those surveys facilitates the use of the available soil information until more adequate surveys for current uses can be provided in the portions of those counties most in need of more adequate surveys for various purposes.

Another comparison possible with the data at hand is, how well do the sample data agree with the series mentioned in the descriptions of the map units. Table 3 shows such a comparison for three counties with recently updated map unit names and descriptions (Tuscola, Oceans and Newaygo) and the survey completed in 1973 in Eaton County. In the first three agreements with the descriptive legends are SO to 92X. I" Eaton County 74% of the sample observations of series are referred to in the map unit descriptions.

Finally, updated names and legends of the map units mentioned above were all published older soil surveys with line maps. The dates of completion of the original surveys and their updatings are shown in Table 3. Each of those counties has elected to enlarge those published soil maps and reproduce them on the most recent available aerial photography along with the updated legends and modern interpretation sheets in a companion volume. The total cost for field work and publication has amounted to only about 5X of the cost of resurveys of the areas. That expense is easily justified for the useful information salvaged, the improved basis for supplying most needed information where and when needed, and the improved quality control the application of these techniques makes possible on current surveys.

I suspect that soil surveys of similar vintages and details elsewhere in the North Central Region may be found to have similar utilities and limitations to those studied to date in Michigan.

I 'believe similar updating studies should be carried out on most surveys completed since 1920 in Michigan. We have not yet applied these updating techniques to the Land Type (Soil Association Maps) made in northern Michigan for general land use planning purposes in the 1930's and 1940's.

These point observation samples are the simplest and least expensive quality evaluation techniques available to date, perhaps more elaborate procedures with better statistical parameters are also needed in some situations. To attempt less at this stage of soil science in the making and interpreting of soil surveys for various purposes it seems to me is untenable.

Attachment No. 1

Table 1. Percentage agreement of the current or updated map unit names in Michigan Counties with sample observations of various soil scientists.

County, date and observer	Number of observation	% Agreement of observations with parts of map unit names or soil management groups: Series	Surface Texture	Slope Class	Erosion Class	Mgmt. Groups
Clinton, 1973 G. Weesies, SCS	64	52	78	95	98	61
Eaton, 1973 E.P. Whiteside, MAES	78	44***	70	80	88	55
Washtenaw 1973 MAES scientists	(1787)*	(55)	-			(62)
Newaygo, 1939 (updated, 1973)	50	66	64	90		66
D. Mokma, MAES	(1511)	(53)	-			(61)
Oceana, 1933 (updated, 1972) D. Mokma, MAES	(948)	(62)	-			(71)
Tuscola, 1926 (updated. 1973) D. Mokma, MAES	(1250)	(54)	-			(62)
Antrim**, 1923 (updated, 1975-76) D. Mokma, MAES & D. Buchanan, SCS	(1175)	(55)	-			(66)

***Includes similar series mentioned in the report descriptions only.
** For 10 townships where updating done.
* Numbers in parentheses based on observations used in updating.

Table 2. Aerial percentage of counties in map units with one, two, three or contrasting series in their names.

No. of series in names	Updated surveys and map dates				Recent surveys and map dates	
	Antrim 1923	Tuscola 1926	Oceana 1933	Newaygo 1939	Muskegon 1940	St. Clair 1968
1	32	22	30	58	42	68
2	67	59	69	39	58	26
3	1	19	1	3	0	6
contrasting	4	29	3	14	0	13

Table 3. Percentage of sample observations agreeing with series in the descriptive legends.

County	Tuscola	Oceana	Newaygo	Baton
Date completed	1926	1933	1939	1973
Date updated	(1974)	(1972)	(1973)	--
% Series Agreement	81*	92*	88*	
			80**	74***

* Based on total observations in the updating.
** Based on an independent sample after updating or mapping.
***This includes soils mentioned in the descriptions without their series names.

TRANSECT METHODS FOR DETERMINATION OF THE COMPOSITION OF SOIL MAPPING UNITS*

William M. Johnson, Principal Soil Correlator,
Berkeley, California**

Knowledge of the kind and extent of the various components of soil mapping units is a necessity for proper soil classification and for useful interpretations. This is true whether the mapping units be complexes, associations of phases of soil types. Even in a relatively "pure" phase of a soil type there are usually some inclusions of unlike soils and some variability in soil characteristics within the defined phase. Soil scientists commonly estimate the proportions of the different kinds of soils present from scattered observations made during the course of mapping. Occasionally the soil surveyor makes highly detailed maps of selected small areas showing the boundaries of all taxonomic soil units present. Then by planimeter or other device, he determines the area of each kind of soil. By extension of these sample results he estimates the composition of the mapping units throughout the soil survey area. Neither of these procedures is entirely satisfactory, the first because it is inaccurate, the second because it is costly and time-consuming. Transect methods provide quick and easy ways of' accurately estimating the composition of soil mapping units.

Principle of Transect Methods

Transect methods of area determination depend on the principle that total length of a given body along a straight-line transect is directly proportional to the area of that body within the limits of the larger delineation transected. Transect methods used in the Soil Survey are equivalent to Rosiwal transects 2/ of thin-sections used by petrographers to determine the composition of rocks. Chayes 1/ has given the mathematical proof of the validity of the technique.

Procedure

One of two transect methods may be used, depending upon the distinctness and ease of recognition of soil differences in the field. The first, the line-intercept method, is quicker if the observer can recognize at sight each kind of soil (or gradation in soil) as he passes its boundary. The second, the point-intercept method, is required if the soil boundaries are not easily observable or if the kinds of soil present have not yet-been recognized and catalogued.

The line-intercept method: The surveyor selects the directions of transects at random. Starting at one edge of the area under study, he walks along a straight line in the pre-selected direction, counting his steps. He notes the number of steps taken at each boundary between kinds of soil and records

* Taken from Soil Survey Field Letter, SCS, June 1961

** Presently, Deputy Administrator for Technical Services, SCS the number in his notebook. Upon reaching a pre-selected point, or the far boundary of the study area, he stops, records the total number of steps at this point, and selects at random the direction of his next transect. After several transects have been measured in this fashion, the results are totalled and averaged to obtain the proportions of each kind of soil. A page from the surveyor's notebook then might look like this:

Soil mapping unit symbol:
13482

Transect No. 1

Number of Steps	Kind of Soil
0	
11 -- 89 11	134A 157
89 - 274	134B
274 - 316	157
316 - 344	134A
344 - 384	157
384 - 500	1348

Transect No. 2

Number of Steps	Kind of Soil
0 - 177	134B
177 - 270	157
270 - 292	134A
292 - 333	157
333 - 363	134A
363 - 500	1348

Soil	Total Steps, All Transects	Percent of Area
134A	91	9.1
1348	625	62.5
157	284	28.4

Point-Intercept Method: As in the line-intercept method, the surveyor first selects at random the directions of his transects. Next, he walks each straight-line transect, counting his steps as before. In this case, though, he does not know or cannot recognize the boundaries between adjacent kinds of soil. Therefore he stops at regular intervals, say every 25, 50 or 100 steps, depending upon the size of the area and the predicted complexity of the soil pattern. At each stop he excavates or augers the soil, examines and classifies it. The kind of soil is recorded in the field notebook at each stop, opposite the number of that stop. After a number of transects have been completed with this procedure, the results are totalled. The number of steps assigned to each kind of soil is proportional to the area of each kind of soil within the study area.

Standards and Errors

The transect methods require random selection of the transect directions. They also require that a sufficient length (or number of stops) be covered to give estimates within the permissible limits of error. In order to characterize a given mapping unit in terms of proportions of its separate components (kinds of soils) it is not necessary to know exactly the percentage of each. The following table suggests permissible limits of error in estimating the proportions of the more and less extensive components of mapping units in standard detailed soil surveys:

Proportion of the Total Area of the Mapping Unit Occupied by a Given Kind of Soil	Allowable Error in Estimating Proportion, Percent
3/10 - 9/10	+ 10
1/20 - 3/10	± 20
less than - 1/20	± 50

The number and length of transects required to achieve accurate estimates varies with the regularity and fineness of the soil pattern. Very irregular patterns and those that include occasional small bodies of unlike soils require more transect length per unit of area than those with regular patterns and no inclusions of very minor extent. Statistical analyses can be applied to transect data whenever it is necessary to determine how accurate the estimates are.

It is not necessary for the surveyor to know his length of step, because the transect methods are used to estimate proportions rather than absolute values. It is necessary, though, that the surveyor's steps be uniform in length.

Example

The following example will serve to illustrate the use of both line-intercept and point-intercept methods. Figure 1 shows a sample map delineation (the heavy peripheral line) with the three included soils also delineated (light interior lines). The four straight transect lines are marked by dashed lines A-A', B-B', C-C', and D-D'. The line-intercept stops are shown by small dots superimposed on the transect lines. After estimating the composition of the whole map delineation by both methods, the true proportions of the three components were determined by cutting and weighing. Results are given in Table 1.

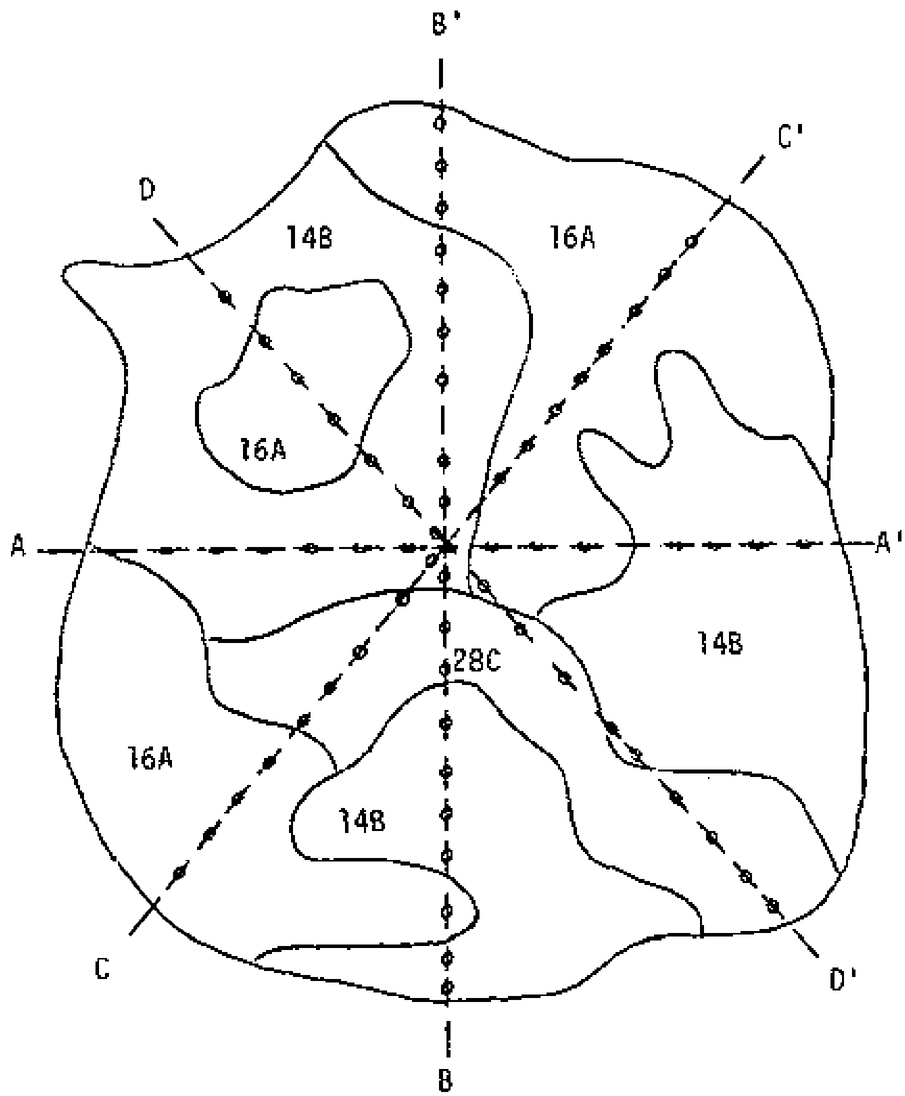


Figure 1

Soil Component Symbol	True Proportion of Total	Line-Intercept		Point-Intercept	
		Length	Est. Proportion of Area	No. of Stops	Est. Proportion of Area
16A	34.4%	281	33.6%	23	36%
14B	49.7%	394	47.1%	29	45%
28C	15.9%	162	19.3%	12	19%

Table 1. Comparison of estimated proportions, using line-intercept and point-intercept methods, with true proportions in a sample map delineation.

REFERENCES

1. Chayes, F. 1956. Petrographic modal analysis; an elementary statistical appraisal. John Wiley and Sons, New York.

2. Rosiwal, A. 1898. Uber geometrische. Gesteinsanalysen. Verhandl. der K. K. Geol. Reichsanstalt, Wien, pp. 143-175.

SCS-50
JANUARY

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

MAPPING UNIT RECORD

158

Card	STATE	NAME OF SOIL SURVEY AREA	SURVEY ACREAGE BY COUNTIES			
			COUNTY 1		COUNTY 2	
			IN AREA	TOTAL	IN AREA	TOTAL
A 1						
A 2						
A 3						

Card	FIELD SYMBOL	KIND	FIELD MAPPING UNIT NAME	MAPPING UNIT ACREAGE	
				COUNTY 1	COUNTY 2
B 1					
B 2					
B 3					

Card	RECOM SYMBOL	RECOMMENDED MAPPING UNIT NAME
C 1		
C 2		

Card	PUBLICATION SYMBOL	DATE MO YR	APPROVED MAPPING UNIT NAME
D 1			
D 2			

Card	PER-CENT OF UNIT	INTERPRETATION RECORD NUMBER	CRITICAL PHASE CRITERIA (use first line for single-taxon unit or first taxon of multi-taxa unit. second line for second unit, etc.)		
			SLOPE	USDA TEXTURE	OTHERS (flooding, growing season rainfall, erosion. aspect, etc.)
E 1					
E 2					
E 3					

ADDITIONAL SYMBOLS ON FIELD SHEETS (if more than 14, use second line)

Card	1	2	3	4	5	6	7	8	9	10	11	12	13	14
F 1														
F 2														

ADJUSTED LAYER DEPTH FOR MAPPING UNIT OR COMPONENTS OF MULTI-TAXA UNITS

Card	MAPPING UNIT OR FIRST TAXON						SECOND TAXON (use second line for third taxon)					
	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
G 1												
G 2												

RANGE SITE NAME (use first line for single-taxon unit or first taxon of multi-taxa unit, second line for second unit, etc.)

Card	
H 1	
H 2	
H 3	

KEYPUNCH OPERATOR DUPLICATE FIELD SYMBOL ON ALL CARDS

REMARKS:

General.
The form is designed for direct keypunching. Print all entires one character per block, and use upper-case for alphabetic characters. Leave unused lines blank. Use no commas in numeric fields. Put initials of the recorder and the date in upper right-hand comer, e.g., KKY 10-25-73. Each time a revision is made enter initials and date below it.

Card Type A.
Only one set of A-type cards needs to be filled out and keypunched. On all other forms enter at least enough information to identify the survey area.
Enter the 2-character alphabetic state symbol, the complete name of the soil survey area, and the pertinent county acreage data.
If the survey area is in a single comfy, enter under "County 1" in the "I" Area" column on line A1 the acreage that is within the survey area. Enter the total county acreage in the "Total" column. Usually these acreages will be the same.
If the survey area is in more than one county enter the acreage data for the second county under "County 2" on line A1. Enter the data for third and fourth counties on line AZ, etc. Enter the county data in the same sequence as listed in the survey area name. Use a second form if there are more than 6 counties in the survey area.

Card Type B.
Enter the current field symbol in the designated field a" line B1. The symbol must contain 5 or less characters. (The keypunch operator will enter the symbol automatically on all other cards of type B through H that are used.) Other symbols used to identify the mapping unit on field sheers are listed on card type F.
In the "Kind" column enter a 2-character code that indicates the kind of mapping unit. For the first character enter one of the following:

Code	Explanation
A	Association - Enter an A when mapping unit is an association of series, variants, taxadjuncts, miscellaneous land types or classes in categories above the series.
C	Complex - Enter a C when mapping unit is a complex of series, variants, taxadjuncts, miscella-"ecus land types or classes in categories above the series.
F	Family or higher in taxonomy - Enter an F when a single taxonomic unit is named for a class in a category above the series.
M	Miscellaneous land type - Enter an M when a single taxonomic unit is a miscellaneous land type.
S	Series - Enter an S when a single taxonomic unit is a series.
T	Taxadjunct - Enter a T when most or all of the soils in mapping unit are taxadjunct to the named series.
U	Undifferentiated group - Enter a U when mapping unit is a" differentiated group of series. variants, taxadjuncts, miscellaneous land types or classes in categories above the series.
V	Variant . Enter a V when a single taxonomic unit is a variant of 8 series.

For the second character of the code enter one of the following:

Code	Explanation
D	Mapping unit used in detailed survey.
R	Mapping unit used in reconnaissance survey.
E	Mapping unit used in exploratory survey.

The symbols in the "Kind" field may change during the course of the survey, e.g., from 'I to S. The symbol refers to the latest mapping unit "me entered.
Enter field me of mapping unit and the acreage in each county (if known). If the mapping unit acreage is to b-e separated for more than two counties, enter the acreage for the third county on line B2 under "County 1", acreage for the fourth county on line B2 under "County 2", etc. Continue name of mapping unit a n second line if necessary.

Card Type C.
Enter the symbol and name of mapping unit recommended for the field correlation. Continue name on second line if necessary.

Card Type D.
nter the publication symbol and the mapping unit name approved at the final correlation. Enter date (month and year) that mapping unit is approved, e.g.. 12/73. Continue name of napping unit a" second line if necessary.

Card Type E.
Under "Percent of Unit" leave blank for all single-taxon units. For multi-taxa units enter the estimated percentage of the total mapping unit occupied by the give" tam". The sum of the named taxa may not equal 100 percent. Enter rhe information for each taxon in the me sequence as the taxa are listed in the mapping unit name--the first tam" on line F1, the second on line F2, etc.
Under "Interpretation Record Number" enter the unique identifier for the soil interpretation record to be associated with the give" taxon; that identifier is 0" the tap of the computer-printed interpretation record, e.g., TX0042.
For soils classified at the family level or higher in the taxonomy or variants (identified by F or V under "Kind" o" card B1) that are not coordinated with other states and regions, prepare a separate Soils-5. These records are to be used only for the survey area for which the,' were developed.
Do not fill out a Soils-5 form for miscellaneous land types.
Under "Slope", enter the slope ranges for each taxon, e.g., 2-5.
Under "USDA Texture" enter the textural symbol including modifier of the surface layer, e.g., GR-L.
Under "Others" enter the critical phase terms on the interpretation record other than slope or surface texture that are needed to select the correct interpretation for the taxon, e.g., V. STONY, RARE, COMMON, PROTECTED, etc. Use the same terms to define the critical phase criteria as are used in the interpretation record.

Card Type F.
List additional mapping unit symbols that have been used on field sheets. If more than 14, use second line.

Card Type G.
This card type can be used to adjust the layer depths or delete layers give" in the interpretation record to fit the mapping unit. Enter a dash in the layer to be deleted. If "a adjustments are needed. leave blank. Use the first 6 columns on the first line to make changes in a single-ram" mapping unit or the first taxon in a multi-taxa unit. The 6 columns to the right a" the first line are for the taxon that appears second in the name of a multi-taxa unit, the third taxon on the second line. The layers are numbered in sequence from the top down as indicated in the interpretation record.

Card Type H.
Enter the range-site name if applicable. Use the first line for the range-sire of the entire mapping unit or the first taxon of a multi-taxa unit, the second line for the second taxon, and the third line for the third taxon.

Remarks
Record facts that will be helpful in classifying or correlating the mapping unit. Remarks will not be keypunched.

EVALUATION OF PHOTOGRAPHY AS RELATED TO THE SOIL SURVEY OF CLAY COUNTY, MINNESOTA

Three kinds of photography have been available for various parts of Clay County. The photos include black and white pan for the entire county. During the spring of 1974 the northern tier of townships were photographed for the purpose of evaluating color IR transparencies and their black and white internegatives as a tool in speeding and improving soil survey operations. This original flight was supplied at a scale of 1:40,000. An additional area of about 3 townships was photographed during the spring of 1975 to provide these IR photos at a scale of 1:20,000. This is the publication scale for Clay County. The remaining areas were photographed the spring of 1976 so color IR transparencies and black and white internegatives are now available at some scale for the entire county.

Theinitial photography was flown in June and some difficulties ware encountered. The spring of 1974 was initially quite dry with some early spring tillage. This followed a wet period delayed spring field operations. The color IR transparencies that relate to vegetative growth therefore revealed various stages of growth on seeded fields, while other fields ware just cultivated and others had no spring cultivation. These conditions resulted in a masking of detail on vegetated and cultivated fields. It·was therefore difficult to relate soil boundaries accurately across a given area by photo interpretation. The differences on photographs relating to vegetative cover ware not so great on black and white IR internegatives and these photos showed sharp detail and contrast except where fields were recently cultivated. Some of this detail was significant to soil boundaries as related to the survey legend. Careful field control was needed to determine what detail represented mappable soil differences. This task was more difficult because of the necessity to adjust interpretations from a 1:40,000 to a 1:20,000 scale. The survey party found that this factor plus the photo detail related to cultural practice and time of flight reduced the value of this initial photography as a tool to speed and improve soil survey operations.

The photos supplied from the photography of spring 1975 were of excellent quality. These were flown at a time that provided the most uniformity possible as related to soil surface condition. In addition, these photos were supplied at the county mapping scale and used as field sheets with no transfer or adjustment of scale necessary. The photos supplied in this May 1975 flight were all on valley landscapes with soil textures ranging from silty clay to fine sand. All soil mapping on this area was accomplished "sing the black and white IR internegatives. These photographs provided the mapping party with excellent contrast and imagery., It should be noted that on some areas the contrast and detail was exaggerated and not all differences related to mappable separations. These photos did, however, show meaningful differences in sharp enough imagery so that more precise soil boundaries could be drawn. This sharp imagery and detail also resulted in accurate surveys with less field control. In comparison, the black and white pan photos generally have the same imagery but contrast is so variable it is more difficult to interpret. Accurate Lines separating soils are therefore difficult to draw and more field control is necessary for acceptable levels of quality. In addition some mapping units proposed for separation, like wetter phases of Fargo soils, are not easily visible on the landscape and have soil morphologic features that are similar. The soil condition is however significant to use and management as related by numerous discussions with owners and operators. This difference in wetness condition is visible in sharp detail on the black and white IR internegatives and only slightly or non visible on the pan photos. The mapping party feels very strongly that the flight provides photos that are so much superior to mapping this landscape and that the pan photos are obsolete by comparison. Where a few areas in these kinds of landscapes were mapped on pan photography they experienced considerably more difficulty in delineating soils. This is especially true when experiences are more limited and the soil scientist is not sensitive to very slight differences in imagery as they may relate to meaningful soil separations.

The colored IR transparencies, supplied with this photography, basically provided the survey with little additional as a resource to expedite soil survey operations. On a few questionable areas they did provide slightly different imagery that had interpretive value. They are difficult to work with in the field however since the portable light tables are rather cumbersome. They are also difficult to keep clean since dust adheres easily to the transparency or its cover.

On a few ares of the 1974 - 1:40,000 scale flight the IR internegatives were enlarged to the 1:20,000 scale. These enlargements also provided photos with sharper, more meaningful imagery than pan photos. They were not as sharp as the 1975 1:20,000 scale flight however. An under exposure in the enlargement process seemed to be responsible for some of the reduction in quality. The weight of paper used also relates to the quality of photos. Paper used should be no lighter grade than that used for the original flight photos developed.

The remaining area of Clay County was photographed the spring of '76. This coverage provided stereocoverage for the upland landscapes only. The same comments on quality and use apply to this flight when relating to lake plain landscapes. It should be noted, however, that the quality of IR internegatives from this flight were inferior to those of the 1975 flight. Under exposure of these negatives resulted in reduced contrast. Some of these were returned and reprocessed for improved quality. It should be also noted that the IR internegatives have slightly less value in upland landscapes. This is true because here separations are commonly made on a distinct relief pattern that is related to soils and their position in the landscape. A sharper imagery does however allow for more accurate placement of lines. The stereo quality of the IR internegatives is also considerably better than that for the pan photos supplied in Clay County.

In summary our experience with photography in the Clay County, Minnesota soil survey leaves the following conclusions:

1. Photography should be of the same scale as the published survey.

2. Time of photography is important to the uniformity of imagery across a given landscape.

3. The IR internegatives provide the most useful photographic product for accelerated soil surveys we have worked with to date.

4. To be most beneficial the IR photos should be supplied from a single flight with careful attention to time of flight and quality of reproduction.

5. The IR photography allows us to accurately separate significant soil conditions where pan photos give little or no indication of where to draw lines separating these conditions.

6. Although IR photos aid any soil scientist in napping, they are of particular aid to those with less experience.

7. It is difficult to assess the total value of this improved photography but depending upon landscapes and complexity it would seem to be worth an additional expenditure of from 25 to 75 percent.

Malvern N. Jacobson
Soil Scientist, SCS
Party Chief - Moorhead, Minn.

NATIONAL TECHNICAL WORK-PLANNING CONFERENCE

OF THE COOPERATIVE SOIL SURVEY

January 30 - February 4, 1977
Orlando. Florida

COMMITTEE 3. WASTE TREATMENT ON NAMED KINDS OF SOILS

Charges: Using the interim guide for rating limitations of soils for disposal of waste (Advisory Soils-14, May 8, 1973), previous reports of this and the Organic Soils Committee and reports of regional committees, improve national guidelines for waste treatment on named kinds of soils.

1. Include limitation ratings for national application.

2. Include principles for developing soil potential ratings for appropriate local areas. The application of these principles should be demonstrated on examples for potential ratings for at least two and preferably four survey areas from contrasting climatic areas.

3. Include ratings for the following materials:

   a. High N feedlot and dairy waste.

   b. High BOD secondary treatment plant residues (sludge).

   c. Low BOD secondary treatment plant effluent.

Introduction:

Information about soil suitability and limitations for waste disposition is needed wherever human or animal populations are concentrated within limited land areas. Land nearby for waste disposition also often becomes increasingly less available. Problems in waste disposition become regionally oriented when treated land is used to produce crops. Manure utilization on arid croplands is often limited by availability of irrigable land.

Three work groups were established to review and assess important problems related to soil uses in waste management. Highlights of the work groups are summarized in the Committee report. Reports of the three work groups with documentation are appended.

General Recommendations:

Those directed specifically to Work Group I, assessing national application of guides to soil limitations; Work Group II, animal manure; and Work croup III, sewage sludge; are presented in respective reports.

1. Nitrogen utilization be reviewed and refined by crops so that better estimates of loading rates can be made by named kinds of soils.

2. Allowances be made to permit greater specificity in state than in national guidelines.

3. Heavy metal investigations of soils and plants should be strongly supported and expanded, so that consequences and magnitude of changes in soils with sludge application can be properly assessed. Selective sampling Of soils and use of analytical methods with sufficient sensitivity is essential.

4. Effort should be made to assess waste disposition by groups of geographically associated soils on landscapes, so that patterns of waste movement and their consequences on land can be more adequately understood.

5. Committee 3 should be continued.

Work Group I. Assess National Application of Guides to Soil Limitations

A canvass was made of state and regional offices to compile lists of soil ratings for waste disposal. A summary of responses is presented:

Total states responding	43
I. States responding with brief statements but lacking soil rating lists	33
II. States submitting technical guides based partly on Advisory Soils-14	5
III. States submitting rating by soil series	5

Attention of the Committee 3 report is focused on the list of soil ratings received from Wisconsin, Michigan, New York and Pennsylvania. Evaluations of soil limitations are based on the value of manure as fertilizer in each of the states, and not as a waste product needing disposal.

Ratings are compared for 21 common soils of Wisconsin and Michigan. Advisory Soils-14, table 2, was used as the primary guide in Michigan; in Wisconsin it was used with slight modifications.

Fourteen soils common to Wisconsin and Michigan were given essentially the same rating (table 1). Soil ratings for manure acceptance reflect important characteristics associated with family groupings of soils.

Ratings for seven other common soils did not differ by more than one class (table 2). Two sandy soils were rated more severely in Wisconsin than in Michigan and three fine-textured soils less severely. Range of series characteristics probably contributes to differences noted among the fine-textured soils. For example, the Blount and Morley soils in Wisconsin have moderately slow permeability and are rated to have moderate limitation; in Michigan, these soils have slow soil permeability and the rating is downgraded. How rapid soil permeability has influenced soil ratings given the Chelsea and Rubicon soils in the two states are described in detail in the Work Group I report (attached). The use of 6 inches of available water capacity in Wisconsin rather than 7.8 inches in Michigan probably contributes to different ratings given the Emmet and Fox soils.

In New York and Pennsylvania ratings are based on capability of plants to utilize the N in the manure. The best soils receive a maximum manure loading rate of 30 T/A/yr and lower rates are set as soil limitations increase. The application of this approach is illustrated by comparing ratings for two broad soil groups common to the two states.

In New York, soils with fragipan and skeletal soils (table 3) receive a higher rating (class 1 $\approx$ 30 T/A/yr) than do similar soils in Pennsylvania (class 2 $\approx$ 24 T/A/yr). Similarly, soils with moderately good drainage in New York (table 4) are rated higher (class 1) than are similar soils in Pennsylvania (class 2). Criteria for recognizing soil classes within each state appear to be applied uniformly.

Poorly drained and very poorly drained soils in Wisconsin, Michigan, New York and Pennsylvania have uniformly received the lowest rating for accepting animal manure. Similar soils in the Pacific Northwest are considered the best soils for manure disposal.

Recommendation:

1. Comparisons of ratings assigned common soil in adjoining states indicate that soil guidelines are useful and can be applied consistently within states in the humid region. A similar assessment of selected soils of arid regions is needed.

Work Group II. Animal Manure

In arid regions (moisture deficit and moisture tension regimes), feedlots tend to be centered around production areas of feed and forage crops. Irrigation is an essential component of crop production. Disposition of feedlot waste on irrigated land in places has resulted in high NO_3-N levels in ground water. Presence of substratum NO_3-N of geologic origin accentuates hazards from excess NO_3-N in water. Leaching salts from manure with irrigation is essential to seedling establishment and minimization of salt damage of soils.

In humid regions (moisture sufficient regime), animal manure has historically been viewed and utilized as plant nutrient sources, and revision of loading rates has been made to minimize environmental pollution, principally streams.

Recommendations:

1. Cation exchange capacity and soil texture be added as additional criteria to rate soils.

Work Group III. Assess guidelines for land application of sewage sludge (ref. Advisory Evt.-11, dated April 30, 1976)

The attention of this work group was directed to assess concentrations of Cd, Zn, and Zn/Cd ratio in plants grown on sludge-treated soils under field conditions. Data from Minnesota, Wisconsin, Illinois, Maryland, and Alabama were available for this purpose. Attention was directed primarily to results from these five states because data were available on a common plant - corn.

Cadmium loading rates (kg/ha) were calculated from Cd concentrations in sludge and sludge application rates to provide a common base between studies. Cadmium concentration varied with sludge source and rates of sludge applied by the different investigators.

The Zn data in sludge-treated soils were reduced to a common Zn loading rate (kg/ha) in a similar manner.

Analytical methods and their application to evaluating heavy metal data of soils and sewage sludge were assessed.

Principal findings:

1. Cadmium concentration in corn tended to increase with Cd loading rate. The Cd concentration ranged from about 0.2 ppm to more than 22 ppm. Corn grown on soils with the highest rate of sludge applied had the most Cd. Effects of soil differences were most evident between Cd loading rates of 1 to 10 kg/ha.

2. Zinc concentration in corn also increased with Zn loading rates. The Zn concentration ranged from about 70 ppm to nearly 400 ppm. Soil differences were reflected in plant Zn concentrations at comparable Zn loading rates.

3. Zinc/Cd ratios tended to be lower in corn grown in Maryland and Alabama than in corn grown in Minnesota and Wisconsin. Higher concentrations of Cd in corn grown on Ultisols than in Argiboralls of Wisconsin appeared to influence how Zn/Cd ratios changed.

4. General observations indicate that soil systems tend to be overloaded with high sludge applications so that the specific role of CEC becomes masked out. Critical Cd levels have not been defined but corn will have more than 5 ppm of Cd if Cd loading rates exceed 10 kg/ha.

Presence of calcareous subsoils and substratum appeared to be as effective as increasing CEC to minimize Cd movement from sludge-treated Soils through a food and feed chain.

5. Total analysis (carbonate fusion or HF treatment), acid extraction (0.1 N HCl) and chelates have been used to assess heavy metal concentrations in sludges and sludge-treated soils. No one analytical approach has been found to meet all needs for making assessments of sludge loading rates on soils and their impact on environmental quality and quality of foods and feeds (appendix - G. Holmgren).

Recommendations:

1. The work group recommends that soil pH and presence of calcareous horizons be considered as additional criteria for use when soils are rated for sludge disposal. High soil pH and carbonates while interrelated, probably will decrease levels of Cd in plants grown on sludge-treated soils.

Lime application rates to enhance plant growth may not coincide exactly with rates that would decrease plant cadmium concentrations. Presence of naturally occurring carbonate horizons should be beneficial, especially where trenching techniques are employed.

2. Conclusions based on short-term studies should be confirmed from a few long-term studies to assess the role of mineralization with time.

The role of CEC of soils probably will increase as sludge undergoes mineralization with time.

Joe Kubota, Chairman
O. F. Bailey
C. R. Berdanier
B. L. Carlile
C. E. Fogg
R. F. Harner
D. E. 'Hill
G. S. Holmgren
A. J. Klingelhoets
G. J. Latshaw
L. J. Lund
M. L. Markeley
R. B. Parsons
J. E. Witty

Table 1. Soil groups of Wisconsin and Michigan given common ratings for accepting animal manure

Rating	Soil Family			Series
Slight	Loamy	fl, m, m	Typic Hapludalfs	Miami
Moderate	Sandy	s, m, m	Psammentic Hapludalfs	Spinks
		s/l, m, f	Alfic Haplorthods	Menominee
	Loamy	col, m, m	Aquollic Hapludalfs	Wisepi
		fl, m, m	Aquollic Hapludalfs	Kibbee
Severe	Sandy	m, m	Typic Udipsamments	Oakville, Plainfield
		s, m, f	Entic Haplaquods	Augres
		s, m, m	Typic Haplaquolls	Granby
	Loamy	col, m, m	Typic Haplaquolls	Gilford
		fl, m, m	Typic Argiaquolls	Brookston
	Peats	euic, m	Typic Medisaprists	Houghton
	Mucks	s or s skel, m, m	Terric Medisaprists	Adrian
		m, euic	Limnic Medisaprists	Edwards

Table 2. Soil groups of Wisconsin and Michigan differing by one class in soil rating for accepting comparable manure application

Soil family			Series	Rating*	
				WI	MI
Sandy	m, m	Alfic Udipsamments	Chelsea	Se	M
	s, m, f	Entic Haplorthods	Rubicon	Se	M
Loamy	col, m, f	Alfic Haplorthods	Emmet	S	M
	fl over s skel m, m	Typic Hapludalfs	Fox	S	M
Fine	f, illitic, m	Typic Hapludalfs	Blount	M	Se
		Aeric Ochraqualfs	Del Ray	M	Se
		Typic Hapludalfs	Morley	M	Se

*S - slight; M - moderate; Se - severe.

Table 3. Soil ratings for manure application as reflected by fragipan and skeletal soils

Soil family		Number of series	Rating NY	Rating PA
col, m, m	Typic Fragiochrepts	6	1*	2†
col, m, f	Typic Fragiorthods	1	1	2
co si, m, m	Typic Fragiochrepts	2	1	2
1 skel, m, m	Typic Dystrochrepts	3	1	2
	Glossoboric Hapludalfs	1	1	2
1 skel, m, m	Dystric Eutrochrepts	1	1	2
col/s or s skel, m, m	Fluventic Dystrochrepts	1	1	2

*Application rate of 30 T/A/yr - New York.

†Application rate of 24 T/A/yr - Pennsylvania.

Table 4. Soil ratings for manure application as reflected by soil family characteristics: New York and Pennsylvania

Soil family		Number of series	Rating	
			NY	PA
col, m, f	Aquic Fragiorthods	1	1*	2†
col, m, m	Aqueptic Fragiudalfs	1	1	2
	Fluvaquentic Dystrochrepts	2	1	2
	Fluvaquentic Eutrochrepts	2	1	2
cosi, m, m	Aquic Dystrochrepts	1	1	2
fl, m, m	Aquic Fragiudalfs	3	1	2
	Aqueptic Fragiudalfs	1	1	2
c, m, m	Aquic Hapludults	1	1	2
fl,s or s skel, m, m	Glossaquic Hapludalfs	1	1	2

*Application rate of 30 T/A/yr - New York.

†Application rate of 24 T/A/yr - Pennsylvania.

Report of Committee 3 - Work Group I

This report consists of two parts. Part I summarizes the responses received from state soil scientists and committee members concerning guidelines used in the various states to determine the limitations of soils for land application of wastes and the ratings given to individual soil series. Part II is the body of a memo from Mr. Fogg concerning"principles for developing soil potential ratings for local areas."

Part I - Responses were received from 43 states and are divided into three groups based on the amount of information the individual state was able to provide. The following is a discussion of each of the three groups and, especially for Group 3, comparisons are made of ratings for common soil series between states with an attempt to highlight the source of variance when the same soil series is rated different by two states.

Group 1. Thirty-three state responses are in this group. The responses, for the most part, consisted of a few brief statements. Twenty-one states indicated that they had not rated any of their soil series for land application of wastes. A few of.these states, however, indicated they had evaluated the soils at a few sites on an individual request basis but apparently did not use any published guidelines. The remaining twelve states of this group have either rated some or all of their series either using the guidelines in Advisory SOILS-14 or guidelines developed by a state agency. Neither the state guidelines nor lists of series rated and their ratings was included with the response, however. Nearly all of the states that have not rated their soils felt there would be a need to do so in the near future. or at least rate the soils near the more densely populated areas:

Group 2. Five states (California, Hawaii, Minnesota. South Dakota, and Washington) are in this group and consists of those states that have developed state guidelines and included an information copy with their response or included their list of soil ratings. These are discussed by state:

California has developed a Technical Note (TN-EVT-7, dated 2/74) concerning "Application of Animal Manures to Land." The portion of the Technical Note dealing with soil limitations was taken from Advisory SOILS-14, dated May 8, 1973. Tables 1 and 2 from this Advisory are included in the Technical Note, hence the criteria used for rating the soil limitations are the unmodified national guidelines. To provide a quantitative basis for applying soil limitation Tables 1 and 2 to their livestock.waste management problems, maximum soil loading rates were suggested depending on the degree of soil limitation. A copy of this table (Table 3) follows.

TABLE 3

Degree of soil limitation to nontoxic biodegradable waste application:	Annual per acre manure application will not exceed the manure produced per annum by:
Slight	6.000 pounds of cattle, sheep, horses 4,500 pounds of swine 3,000 pounds of poultry
Moderate	4,000 pounds of cattle, sheep, horses 3,000 pounds of swine 2,000 pounds of poultrv
Severe	2,000 pounds of cattle, sheep, horses 1,500 pounds of swine 1,000 pounds of poultry

Even though the Technical Note is more than two years old it was not known whether anyone had rated the soils in California for disposal of wastes using the published criteria. It was believed, however, the soils in California should be rated.

Hawaii rated all the soils on the island of Oahu using Advisory SOILS-14. It appears that the groupings obtained was satisfactory except many of the soils were rated as having moderate limitations because they have AWC of less than 7.8 inches. It was felt this was too harsh on the soils and a better break between slight and moderate limitation concerning AWC would be 6 inches.

Minnesota prepared a Technical Note concerning "Agricultural Waste Management." The Technical Note was used in the state as a trial. This note is now being revised and is in draft form dated May 7, 1976 as Agronomy No. 16 (Rev. 1). The information contained in Advisory SOILS-14 dated May 8, 1973 was the basis for the Technical Note. Tables 1 and 2 of the Advisory were combined into one table basically unchanged except soil slope was added as a criteria with 0 to 2 percent slopes having slight limitation, 2 to 6 percent slopes having moderate limitation and over 6 percent slopes having severe limitation. The soils of Minnesota have not yet been rated, however.

South Dakota has prepared a Technical Note (ENVIRONMENT NO. 5 dated 9/3/74) concerning "Guide for Land Application of Animal Wastes." Each of the soil series used in South Dakota are rated for optimal manure application rates based on crop yield on that soil and nitrogen requirements for the crop. As such all the soils are treated equal concerning their limitations for disposal of waste in this guide.

Washington is using "Guidelines for Manure Application in the Pacific Northwest" (EM 4009, Feb. 1976, Washington State University, Pullman, Washington). These guides provide instructions for calculating manure application rates based on nitrogen content of the manure and nitrogen requirements of the crop. The only soil property considered is soil drainage which is used as an aid in estimating a "denitrification coefficient." That is, as the degree of wetness increases the possibility for denitrification is estimated to increase, i.e., higher application rates are made on very poorly drained soils as compared to well drained soils. The ratio in this case is about 1.7:1. This guide also treats all soils as equal concerning their limitation for disposal of waste except it does list "some basic requirements of field application." Some of the statements in this list that involve soil properties are: "There must be no deleterious effects on soil properties. Runoff must be controlled so that there is no pollution of surface waters. Water percolating through the soil profile must not carry excessive nitrate-nitrogen concentrations into ground water aquifiers."

Group.3. Five states (Maine, Michigan, New York, Pennsylvania, and Wisconsin) are in this group. It consists of states that have rated their soil serles with many of the soil series being common to two or more states, hence comparisons can be made directly between these states. Three sets of comparisons will be made; first, ratings given to soil series that are common between Michigan and Wisconsin; second, ratings given to soil series that are common between New York and Pennsylvania; and third, ratings given to soil series that are common between Maine and New York. An attemp will be made to highlight sources of variances when the same soil is rated differently by the two states.

In the following comparison between Michigan and Wisconsin several sets of ratings are listed. In the first column of ratings is that given by Wisconsin based on a slightly modified version of Table 2 in Advisory SOILS-14. The second column is Michigan's ratings for soils based on Table 2 of Advisory SOILS-14. The third and fourth columns are Michigan's ratings for soils based on Table 1 of Advisory SOILS-14 with Column 3 for temporary installations and column 4 for permanent installations. Columns 5 and 6 represent "Hydrologic Limitations" taken from Research Report 195, Soil Limitations for Disposal of Municipal Waste Waters, Michigan State University Agricultural Experiment Station in cooperation with Michigan Water Resources Commission.

SOIL SERIES	Wisconsin's Limitation Ratings	Michigan's Limitation Ratings for Solid Wastes (Adv. SOILS-14)	Michigans Limitation Ratings for Liquid Wastes (Adv.SOILS-14)		Michigan's Hydrologic Limitation Ratings fran Research Report 195	
			Temp.Instal.	Perm.Instab.	Sprinkler	Surface
Adrian	*Se-D,P	Se-D	Se-D	Se-D	VSe-D	VSe-D
Au Gres	Se-D,P	Se-AW,D	Se-AW,D	Se-AW,D	Se-D	Se-D
Blount	M-D,P	Se-D,P	Se-P,D	Se-P,D	VSe-D,P	VSe-D,P
Brookston	Se-D,F	Se-D,P	Se-D,P	Se-D,P	VSe-D,P	VSe-D,P
Chelsea	Se-P	M-D,P,AW	M-D,P,AW	M-D,P,AW	S	S
Del Ray	M-D,P	Se-P	Se-P	Se-P	VSe-D,P	VSe-D,P
Edwards	Se-D,F	Se-D	Se-D	Se-D	VSe-D	VSe-D
Emmet	S	M-AW	M-AW	S	M-P	M-P
Fox	S	M-AW	M-AW	S	M-P	M-P
Gilford	S-D,F	Se-D	Se-D	Se-D	VSe-D	VSe-D
Granby	Se-F,P	Se-D	Se-D	Se-D	VSe-D	VSe-D
Houghton	Se-D,F	Se-D	Se-D	Se-D	VSe-D	VSe-D
Kibbie	M-D	M-D	M-D	M-D	Se-D,P	Se-D,
Menominee	M-P	M-P	M-P	M-P	M-P	M-P
Miami	S	S	S	S	Se-?	Se-P
Morley	M-P	Se-?	Se-?	Se-?	vse-P	VSe-P
Oakville	Se-P	Se-P	Se-P	Se-?	S	S
Oakley	S	S	S	Se-P	Se-P	Se-P
Plainfield	Se-P	Se-D	Se-D	Se-D	S	S
Rubicon	Se-P	M-P,AW	M-AW,P	M-P	S	S
Spinks	M-P	M-P,AW	M-AW,P	M-P	S	S
Wasepi	M-P	M-D,AW	M-AW,D	M-D	Se	Se-D

* 1%e abbreviations for degree and kind of limitations are as follows:

S	= Slight	AW	= Available water
M	= Moderate	D	= Drainage
Se	= Severe	F	= Flooding
VSe	= Very severe	P	= Permeability

When comparing the first four rating columns the overall differences are small. Blount and Morley soils are rated as having moderate Limitations in Wisconsin and severe limitations in Michigan. The reason for this difference is that these two series are defined as having moderately slow and slow permeability. The guides defines soils with moderately slow permeability as having moderate limitations and slow permeability as having severe limitations. Apparently the Blount and Morely soils, as they occur in Wisconsin, are considered to have mostly moderately slow permeability whereas theyarerated in Michigan on the basis of having slow permeability. In Wismnsin's guide soils with rapid permeability are considered to have severe limitations whereas Advisory SOILS-14 (used unmodified by Michigan) includes soils with rapid permeability as having moderate limitations. This differenceresults in the above rating differences for Chelsea and Rubicon soils. Wisconsin's guide also sets the limits between slight and moderate limitations for availablewater capacity at six inches rather than 7.8 inches used in Michigan which results in the rating differences for Emmet and Fox soils. The official Del Ray series description states that these soils have slow permeability. Wisconsin's guide rates soils with slow permeability as having severe limitations; therefore, the moderate limitation listed for Del Ray probably should have been severe.

When comparing the first four rating columns with the last two the principal difference is the result of how permeability is assessed concerning its role. In the SCS ratings, permeability is assessed on the basis of its possible affects on soil aeration and residence time of solublewaste components; therefore, soils that have eitherhighor low permeability rates are penalized. Research Report 195 assesses permeability on the basis of its possible affects on soil aeration only; therefore, thehigher the permeability rate the higher smre it is given. A comparison of the ratings for Chelsea, Emmet, Fox, Miami, Oakville, Cckley, Plainfield, Rubicon, and Spinks soils demonstrates this. Chelsea, Oakville, Plsinfield, Rubicon, and Spinks soils all have rapid or very rapid permeability and have moderate or severe limitations based on the SCS guides and slight limitations based on criteria used in Research Report 195.

Maine, New York, and Pennsylvania's ratings are in terms of application rates of manure and not directly in terms of soil limitations. In the following comparisons, however, it is assumed that application rate is inversely correlated to soil limitation, i.e., the lower the application rate the greater is the soil limitation. Considering only the level and nearly level soil phases, Maine used five application rates whereas New York and Pennsylvania used only four. Because Maine considered a zero applicationrate and New York and Pennsylvania did not, to make comparison easier, Maine's application rates are reduced to four by grouping the lowest two rates. The rates of application can then be compared as follows:

Limitation No.	mine	New York	Pennsylvania
1	50	30	30
2	30	20	24
3	20	15	18
4	10 & 0	10	12

A "Limitation Number" (1 through 4) is assigned to each of the four application rates as shown above to simplify the following comparisons.

COMPARISON BETWEEN MAINE AND NEW YORK

Soil Series	Maine Limitation No.	New York Limitation No.
		3
ADAMS / AGAWAM	3	1
ALLAGASH	4	1
		3
BANGORS	1	1
BELGRADE	2	1
BERKSHIRE	1	1
BIDDEFORD	4	3
CANAAN	4	2
CANANDAIGUA	4	3
CHARLTON	1	1
COLTON	4	3
CRARY	2	1
DEERFIELD	4	1
DIXMONT	4	1
DUANE	2	1
ELMWOOD		1
FREDON	4	3
		3
HADLEY / ESTER	1/3	1
HARTLAND	1	1
HERMON	3	3
HINCKLEY	4	3
HOLLIS	4	2
LEICESTER	4	3

COMPARISON BETWEEN MAINE AND NEW YORK - continued

Soil Series	Maine Limitation No.	New York Limitation No.
LIMERICK	4	3
MACHIAS	4	1
MADAWASKA	4	1
MARLOW	1	1
MERRIMAC	3	3
MONARDA	4	3
NICHOLVILLE	4	1
NINIGRET	4	1
ONDAWA	3	1
PAXTON	1	1
PERU	2	1
PODUNK	4	1
POTSDAM	1	1
RAYNHAM	4	3
RED HOOK	4	3
RIDGEBURY	4	3
RUMNEY	4	3
SACO	4	3
SALMON	1	1
SAUGATUCK	4	3
SCANTIC	4	3
SCARBORO	4	3
SUDBURY	4	3
SUNCOOK	4	3
SUTTON	2	1
SWANTON	4	3
WALPOLE	4	3
WAUMBEK	2	1
WHATELY	4	3
WHITMAN	4	3
WINDSOR	4	3
WINOOSKI	2	1
WOODBRIDGE	2	1

Maine did not publish the soil criteria used in rating their soils, however, the following is New York's criteria:

SUGGESTED MAXIMUM RATES OF APPLICATION FOR FRESH DAIRY MANURE

Tons per acre per year

Drainage class	Depth to Bedrock 20"-40"+	0"-20"
Excessively drained	15	10
Well drained and moderately well drained	30	20
Somewhat poorly drained, poorly drained, and very poorly drained	15	10

In reviewing some of the series common to both states it appears that Maine did not group drainage classes the same as New York, for example, compare the well drained Charlton and Paxton soils with the moderately well drained Sutton and Woodbridge soils. Shallow depth to bedrock is rated differently between the two states: compare the "Limitation No." for the shallow Canaan and Hollis soils. It appears also that Maine considered soil permeability or available water capacity and flooding as criteria which would result in different groupings as compared to New York's.

COMPARISON BETWEEN NEW YORK AND PENNSYLVANIA

Soil Series	New York Limitation No.	Pennsylvania Limitation No.
		2
ALDENGHTS	1/3	4
ALLIS	3	4
ALTON	1	'2
ARMAGH	3	4
ARNOT	3	3
ATKINS	1	4
BARBOUR	1	2
BASHER	1	2
BATH		2
BENSON	2	3
BIRDSALL	3	4
BRACEVILLE	1	3

COMPARISON BETWEEN NEW YORK AND PENNSYLVANIA - continued

Soil Series	New York Limitation No.	Pennsylvania Limitation No.
BRINKERTON	3	4
CAMBRIDGE	1	2
CANADICE	3	4
CANASERAGA	1	2
CANEADEA	3	3
CANFIELD	1	2
CARLISLE	3	4
CAVODE	3	3
CHANANGO	1	2
CHIPPEWA	3	4
CLYMER	1	1
COLLAMER	1	2
DALTON	3	3
DEKALB	1	2
EMPEYVILLE	1	2
ERIE	3	3
ERNEST	1	2
GILPIN	1	2
HALSEY	3	4
HAVEN	1	1
HOWARD	1	2
LACKAWANNA	1	2
LANGFORD	1	2
LINDEN	1	1
LORDSTOWN	1	2
MANLIUS	1	2
MARDIN	1	2
MIDDLEBURY	1	2
MORRIS	3	3
OQUAGA	1	2
PHELPS	1	2
PHILO	1	2
PLAINSFIELD	3	2
RED HOOK	3	3
SC10	1	2
SLOAN	3	4
SWARTSWOOD	1	2
TIOGA	1	1
TUNKHANNOCK	1	2

COMPARISON BETWEEN NEW YORK AND PENNSYLVANIA- continued

Soil Series	New York Limitation No.	Pennsylvania Limitation No.
UNADILLA	1	1
VALOIS	1	1
VENANGO	3	3
VOLUSIA	3	3
WALLINGTON		3
WARNERS	3	4
WAYLAND	3	4
WELLSBORO	1	2
WHARTON	1	2
WILLIAMSON	1	2
WORTH	1	2
WURTSBORO	1	2

The criteria used for grouping New York's soils Was given above. The following is the criteria Pennsylvania used, however, when Pennsylvania developed the four application rates, they combined soil groups 2 and 3 and soul groups 4 and 5.

INTERIM GUIDE

DESCRIPTION OF SOIL GROUPS FOR MANURE APPLICATION

Soil Group Number	Description
1.	Well-drained soils. Deep or very deep. Can hold large amounts of Water without excessive runoff or drainage through the subsoil. Adapted to most crops. High crop yields.
2.	Moderately Well-drained soils. Deep or very deep. Rave soil layers that restrict downward wement of Water. Adapted crops yield well.
3.	Well-drained soils. Variable. Use may be limited because of moderate depth, excessive movement of Water through the subsoil or soil layers restricting water-t. Adapted crops with good management yield well.
4.	Somewhat poorly drained soils. Hard pans of soil layers restrict Water movement through the subsoil. Adapted to wet-tolerant crops. Good management is required for satisfactory crop yields.

5. Shallow, well-drained soils. Pest adapted to shallow-rooted, drought-tolerant crops. Crop yields are usually low.

6. Poorly and very poorly drained soils. Usually not suited for cultivated crops without artificial drainage. May be difficult or notpracticalto drain, Crop yields are moderate to low.

Technical Guide Section III-S
Waste Management System

Pennsylvania- Revised
February 1976

When comparing New York's criteria with Pennsylvania's, one can see that each state did not consider the sarre drainage contributed the same degree of limitation. For example, New York did not consider the moderately well drained class to be a limitation whereas Pennsylvania downrated moderately well drained soils. Also, soil depth classes are handled differently, for example, the well drained moderately deep Gilpin soils received a "Limitation No." of 1 in New York and 2 in Pennsylvania and the shallow Benson soils received a "Limitation No." of 2 in New York and 3 in Pennsylvania. Because New York did not consider restrictive layers as a limitation and Pennsylvania did, resulted in Pennsylvania downgrading all soils with restrictive layers.

Maine, Michigan, New York, Pennsylvania, and Wisconsin considered soil slope as a possible limitation as it influenced runoff and erosion. Maine's guidelines rated soils with slopes between 0 and 25 percent the same but indicated that manure should not be applied on soilswith slopes greater than 25 percent. Michigan (in Research Report 195) used slope breaks of 0 to 2 percent, and 6 to 12 percent. The degree of limitation that they considered each slope class exhibited depended on the soil (infiltration rate) but most of the soils with slopes greater than 6 percent were considered unsuited (at least for application of liquid wastes). New York considered two slope classes, 0 to 8 percent and 8 to 15 percent, with soils having slopes greater than 15 percent notrated. Pennsylvania considered three slope classes, 0 to 8 percent, 8 to 15 percent, and 15 to 25 percent. Because New York's and Pennsylvania's guides concerned application rates, the rates were decreased as gradient increased. Wisconsin also considered three slope classes with slopes 0 to 6 percent presenting slight limitations, slopes 6 to12 percent presenting moderate limitations and slopes greater than 12 percent presenting Severe limitation.

Part II. The following is a discussion on "principles for developing soil potential ratings for local areas" prepared by Mr. C. E. Fogg:

"Advisory SOILS - 14, May 8, 1973, is a useful guide for planning waste management systems incorporating land utilization (or disposal). Its section "Major Interactions Between Waste Materials and Soils" as well as tables 1 and 2 are excellent national guides. Tables 3, 4, 5 and 7 also present reasonable broad guidelines but could be refined locally to represent local conditions.

"Advisory EVT-11, April 30, 1976, (incorrectly distributed as Advisory EVT-30 to some recipients) is a first attempt to relate soil CEC to its potential for safely accepting Zn, Cu, Ni, Cd, and Pb. To be of use at the field level the CEC of local soils must be known. Further refinement at the local level could relate named soils to potential quantities of phosphorus and the various heavy metals they can safely assimilate without adversely affecting crops or being a threat in the food chain.

"Application of waste to land is site specific. A well planned system is the result of inputs fran many disciplines including soil scientists. It must be based on quantitative data about wastes, soils, plants, and climate. Even data from local guides needs to be verified or refined as it relates to a specific site.

"Soil potential ratings for local areas should be the result of input from all involved disciplines. They should contain as much quantitative data as possible to enhance their usefulness to system planners and minimize the amount of site specific investigations required.. Under no circumstances can they be a substitute for interdisciplinary planning and design of alternative complete land application systems including rates, times, and total volumes of wastes to be applied at specific sites.

"As a first step it would be desirable to have the CEC of named soils developed for local areas."

Committee 3 - Work Group I

O. F. Bailey
C. E. Fogg
R. F. Harner
A. J. Klingelhoets
G. J. Latshaw
M. L. Markley
J. E. Witty, Chairman

Introduction

Animal wastes are substances which have high chemical oxygen demand and accumulate during animal raising, holding, or finishing operations. These commonly include excrement, dead animals, and other substances such as feathers or hair. Major problems related to animal waste include potential food contamination, surface and ground water alteration, and odor. The impact of these problems increases with human population density. Waste production can be divided into climatic regions as follows:

1. Moisture sufficient regions (those areas where percolation of soils or unsheltered piles occurs during prolonged periods of most years).
    a. Dairy, poultry, and swine operations are common in this region.

2. Moisture tension regimes (those areas where percolation and evaporation are about balanced during most years).
    a. Feedlots for beef cattle finishing are common in this region.

3. Moisture deficit regions (those areas where evaporation is the dominant moisture factor during most years).
    a. Feedlots for beef and dairy cattle and poultry operations are common in this region.
    b. Grazing with low animal density is common in this region.

Waste handling systems commonly utilize soil loading as a final step. Liquid or solid waste can be applied to soil for nutrient utilization by crops (11). Waste handling systems may utilize lagoons prior to spreading on soil. Systems for handling non-spreadable material such as dead animals include landfill, incineration, and rendering.

Potential problems related to loading soil with animal waste include:

1. Microbial utilization of all available nitrogen if C:N is too small (14)

2. Biological activity varies regionally with both temperature and moisture (14).

3. Nutrient balance and excess nutrient leaching. Nitrification, the conversion of nitrogen from reduced forms to nitrate, requires adequate phosphorus (8), an aerobic environment (5 and 14), and temperature greater than 5" C. (14). Nitrogen will move with percolating water if it is in the nitrate form (1, 3, 14 and 15). Nitrate moves through soils In moisture tension and moisture deficit regions primarily with irrigation water (1, 3, 7, and 14). In some places nitrate has accumulated below the root zones of native vegetation and becomes a hazard to ground water quality when irrigation water or waste in liquid form is applied to the soil (2 and 14). Water from tile drains, however, commonly has nitrate in higher concentration than that in the base flow (13). Nitrate which percolates below the

root zone will probably persist unless denitrification occurs (1, 2 and 14); denitrification occurs in anaerobic zones and is enhanced by addition of energy sources such as glucose (12). An alternate anaerobic pathway for nitrate loss is reduction to ammonia (12). Fine-textured soils will denitrify more efficiently than coarse-textured ones (3 and 6). Roots of plants are the primary absorbers of mobile nutrients: many studies have shown that nutrient application within the regional recommendations for the crop allow roots to absorb nearly all the mobile plant nutrients (4, 6, and 10). In a few places nitrate has been absorbed by plants in sufficient concentrations that grazing animals have adverse metabolic reactions (14). Vegetation from recently abandoned feedlots or from grasslands which have received excess applications of manure should be analyzed prior to grazing.-

4. Animal waste that has not been leeched commonly contains soluble salt (14). When applied to soil in the moisture tension or moisture deficit regions, salts can accumulate in sufficient quantity to decrease crop yield (15). In soils where soluble salts have accumulated, percolating water will carry these in solution (1). Soluble salt is also present in ground water of moisture sufficient regions; however, the concentration is commonly lo" (4 and 5). When little water is percolating through soils of moisture sufficient regions, the groundwater salt concentration measurements of tile effluent can give values five or more times greater than those found in the non-tile flow (13).

Recommendations of Work Group II:

1. Any future national guide designed to rate soil suitability or limitations for assimilating applied animal waste should direct the individual states to design a similar guide. The individual state guides can be more limited in scope of soils and therefore offer more specific criteria.

2. A category for rating cation exchange capacity should be added to the present guide (11). This would provide a means for rating nutrient detention time prior to plant uptake.

3. A category for rating soil texture should be added to the present guide (11). This would provide a means for rating trafficability where needed.

4. Maximum loading rate should be a function of nitrogen content and C:N as in the present guide (11). The maximum rate should be changed from 1½ times the nitrogen required for the crop to a rate determined by some formula with variables for the nitrogen release factors. An example used by D. L. Reddell (9) follows:

Manure Application Rates

The amount of manure which should be added can be calculated from following formulas:

$$SIMN = \frac{FGN}{A\ (1-D)\ (1-L)}$$

SIMN = Soil-Incorporated Manure Nitrogen, lbs. N/acre,
FGN = Fertilizer Guide Nitrogen, lbs. N/acre,
A = Availability coefficient of manure, nitrogen, a fraction of the soil-incorporated total nitrogen transformed to the inorganic form,
D = Denitrification coefficient, a fraction of the available inorganic nitrogen,
L = Leaching coefficient, a fraction of the available inorganic nitrogen stored in the soil.

To calculate the quanity of solid manure applied on a dry-weight basis:

$$SIM = \frac{FGN}{20\ C\ A(1-D)\ (1-L)}$$

SIM = Soil Incorporated Manure, tons/acre on dry basis,
C = Concentration of nitrogen in waste, percent on dry basis.

To calculate the quantity of solid manure applied on a wet weight basis:

$$SIMW = \frac{FGN}{(1-\theta)\ 20CA(1-D)\ (1-L)}$$

SIMW = Soil Incorporated Manure, tons/acre on wet weight basis,
θ = Moisture content of manure on wet basis.

To calculate the quantity of a liquid waste applied:

$$SILM = \frac{100\ FGN}{8.33\ (TS)\ CA(1-D)\ (1-L)}$$

SILM = Soil Incorporated Liquid Manure, gal/acre,
TS = Total Solids in liquid waste, fraction of total weight.

Manure Nitrogen Availability Coefficients for the Firs: 20 Application Years in Warm Climates When a Constant Pace of Manure is Applied Each Year.

Nitrogen in Manure (% dry basis)	Availability Coefficient for the year of application							
	1	2	3	4	5	10	15	20
1	0.20	0.28	0.32	0.35'	0.38	0.52	0.63	0.71
1.5	0.35	0.45	0.50	0.53	0.55	0.65	0.73	0.79
2.5	0.40	0.55	0.58	0.60	0.63	0.73	0.80	0.85
3.5	0.75	0.79	0.81	0.82	0.53	0.37	0.90	0.92
Poultry Manure	0.90	0.91	0.91	0.92	0.92	0.94	0.95	0.96
Anaerobic Lagoon								
Treated	0.30	0.40	0.45	0.48	0.50	0.60	0.68	0.74
Fresh Dairy	0.50	.65	.70	.75	.80	.84	.87	.90

Denitrification Coefficients.

Degree of Soil Drainage	Denitrification Coefficient
Excessive or somewhat excessive	0
Well	0.10
Moderately well	0.20
Somewhat poorly	0.30

Leaching Coefficients.

Climate	Precipitation Only	Precipitation & Sprinkler Irrigation	Precipitation & Furrow Irrigation
Dry	0.05	0.10	0.25
wet	0.15	0.20	0.30

References

1. Bingham, F. T., S. Davis, and E. Shade. 1971. Water relations, salt balance, and nitrate leaching losses of a 960-acre citrus watershed. Soil Science 112:6:410-418.

2. Boyce, J. S., J. Muir, A. P. Edwards, E. C. Seim, and R. A. Olson. 1976. Geologic nitrogen in Pleistocene loess of Nebraska. J. Env. Qual. 5:1:93-96.

3. Devitt, D., J. Letey, L. J. Lund, and J. W. Blair. 1976. Nitrate-nitrogen movement through soil as affected by soil profile characteristics. J. Env. Qual. 5:3:283-288.

4. Gilliam, T. W., R. B. Daniels, and J. F. Lutz. 1974. Nitrogen content of shallow groundwater in the North Carolina coastal plain. J. Env. Qual. 3:2:147-151.

5. Hortanstine, C. C. 1976. Chemical changes in soil solution from a Spodosol irrigated with secondary-treated sewage effluent. J. Env. Qual. 5:3:335-338.

6. Kissel, D. E., S. J. Smith, and D. W. Dillow. 1976. Disposition of fertilizer nitrate appiied to a swelling clay soil in the field. J. Env. Qual. 5:1:66-71.

7. Muir, J., J. S. Boyce, E. C. Seim, P. N. Mosher, E. J. Deibert, and R. A. Olson. 1976. Influence of crop management practices on nutrient movement below the root zone in Nebraska soils. J. Env. Qual. 5:3:255-259.

8. Purchase, B. S. 1974. The influence of phosphate deficiency on nitrification. Plant & Soil 41:3:541-547.

9. Reddell, D. L. 1976. Unpublished data. Texas A&M Univ., College Station, Texas.

10. Schuman, G. E., T. M. McCalla, K. E. Saxton, and H. T. Knox. 1975. Nitrate movement and its distribution in the soil profile of differentially fertilized watersheds. SSSA Proc. 39:6:1192-1197.

11. Soil Conservation Service. 1973.~ Guide for rating limitations of soils for disposal of waste.

12. Stanford, G., J. 0. Legg, D. Stanislaw, and E. C. Simpson, Jr. 1975. Denitrification and associated nitrogen transformations in soils. Soil Science 120:2:147-152.

13. Thomas, W. G. and B. J. Barfield. 1974. The unreliability of tile effluent for monitoring subsurface nitrate-nitrogen losses from soil. J. Env. Qual. 3:2:183-185.

14. Viets, Jr., F. G. and R. H. Hageman. 1971. Factors affecting the accumulation of nitrate in soil, water, and plants. Agr. Handbook 413. 63 pages.

15. Wallingford, G. W., L. S. Murphy, W. L. Powers, and H. L. Manges. 1975. Disposal of beef-feedlot manure: Effects of residual and yearly applications on corn and soil chemical properties. J. Env. Qual. 4:4:526-531.

COMMITTEE 3 -- WASTE DISPOSAL ON NAMED KINDS OF SOILS

Work Group III. Sewage Sludge

This work group focused its attention on Cd and its relation to Zn and Zn/Cd ratio because of their importance in assessment of sludge application on agricultural lands. Cadmium is an element that accumulates in the body of man and animals and is more likely to enter in the food and feed chain than an element like Pb. Lead is largely fixed in soils and is not readily available to plants grown on sludge-treated soils. Zinc is important because it has a detoxifying effect on body Cd, as does Se. While critical levels of Cd remain to be defined, use has been made of Cd levels in plants and Zn/Cd ratios to assess the biological movement from sludge-treated soils to plants grown on the soils.

General guidelines for maximum loading Cd rates are defined in Adv. Evt.-11, April 1976. The effect of sludge-loading rates on different kinds of soils was assessed using plants as a bioassay tool of Cd activity.

Application of Adv. Evt.-11 is field-oriented and publications of field studies were used as primary sources of information. A summary of the publications used, soils and other pertinent information is presented in Table 1. All were from journal articles, except the Wisconsin study. This report (Kelling, Keeney, Walsh and Ryan) has been submitted for publication. Except for Colorado, the reports are from the eastern U.S.

Pertinent data have been selected from these reports. Data for corn were used because this plant provided observations over a wide range of soils. Data for field corn and sweet corn have been combined. Cadmium and Zn loading rates were calculated from concentrations in sludge and application rates to provide a common basis to assess the role of sludge application, soils and their interaction.

Cadmium: A general increase in Cd concentration with Cd loading rates is evident in leaves of corn grown on sludge-treated soils (Fig. 1). Between Cd loading rates of 0.1 to 10 ppm, corn grown on the Sassafras soils (Maryland) tended to have the most Cd, and corn from Hubbard coarse sand (Minnesota) the least. The CEC of the Hubbard soil probably is about the same as that of the Sassafras soil. The Hubbard soil has free carbonates, typically between 60 to 80 inches with extremes of 50 to 100 inches (series description).

Maximum lifetime site application rates of 5 kg/ha for soils with CEC between 0-5 meq/100 g, 10 kg/ha for soils with 5-15 meq/100 g, and 20 kg/ha for soils with more than 15 meq/100 g have been suggested (Adv. Evt.-11). The information presented in Fig. 1 suggests that concentrations in corn leaf may exceed 5 ppm of Cd if loading rates exceed 10 kg/ha of Cd. Higher Cd concentrations might be expected if heavy Cd feeder plants are grown on the same soils. Sorghum-sudangrass appears to be a better feeder of Cd than corn under Wisconsin conditions.

Zinc: The Zn concentration in corn leaves and corn stover (leaves and stalks) increases with Zn loading rates (Fig. 2). For Wisconsin (X), the top series of points are data for corn stover produced on a Warsaw sandy loam, and the bottom series, from a Plano silt loam. The Plano soil has nearly twice the cation exchange capacity (22 meq/100 g) as does the Warsaw soil (13 meq/100 g).

Specific responses of corn to four soils are illustrated in Fig. 3. While the increases in Zn concentration with Zn loading rate are parallel, differences between soils may be important if means are sought to increase the Zn/Cd ratio or if an existing wide ratio is to be maintained.

Zinc/Cd Ratios: The Zn/Cd ratio tends to decrease from south to north in corn leaves and corn stover (Table 2). Differing sludge application rates and soils are confounded in the median concentrations presented. Averages reported by the investigators were used and include values from at least three replicated plots.

The trend appears to result principally from higher Cd concentrations in the southern samples. The Zn concentrations (median) in corn from Minnesota (123 ppm), Illinois (146 ppm), and Maryland (139 ppm) are nearly the same.

In general, data from control plots (without sludge application! showed higher Cd concentrations in plants grown on southern than on northern soils.

Zinc/Cd ratios of plants may be useful if they are used in conjunction with measured Cd and Zn concentrations. The universal application of plant Zn/Cd ratios over unlimited concentration ranges of Cd does not seem reasonable.

Changes With Successive Crops: The Plano soil (fine silty, mixed, mesic) and the Warsaw soil (fine, loamy over sand, mixed, mesic) are both Typic Argiudolls. Cadmium concentrations in corn stover, with one exception, decreases with successive corn crops produced on a sludge-treated Plano soil (Fig. 4). Cadmium concentrations, on the other hand, tend to increase from the second to third corn crop produced on the Warsaw soil. Trends in Zn concentration (Fig. 5) parallel those of Cd (Fig. 4). These observations seem applicable to maximum lifetime loading rates defined in Adv. Evt.-11. The two are morphologically similar and differ primarily in texture and in CEC. Whether the changes in successive corn crops can all be attributed to CEC alone is not known.

The median Zn/Cd ratio is essentially the same (210) when the ratios for the two soils are compared. The Zn/Cd ratio ranged from 159 to 343 for the corn crop grown on the Plano soil, and from 141 to 275 for that grown on the Warsaw soil.

General: Some general observations seem evident from Work Group III activity:

1. A plant like corn appears to have the capacity to absorb relatively large amounts of Cd and Zn in the absence of phytotoxicity. Plant tolerance to Cd appears to exceed tolerance levels for man and animals.

2. Greater use can be made of soil characteristics other than CEC alone to establish maximum lifetime loading rates. Plant uptake of Cd can be lowered with increasing soil pH. Application of lime is emphasized when sludge is applied to land and good advantage can be taken of the natural occurrence of subsoil carbonates, especially with trenching operations. While low loading rates were applied in the Minnesota and Wisconsin studies, the fact remains that these soils have calcareous subsoil and substratum.

3. The increase in plant Cd with Cd loading rates suggests that Cd concentration in sludge should be monitored and sludge application rates be modified to reflect Cd concentration in the sludge applied.

4. The relationship of N in sludge to sludge loading rate and Cd concentration in plants remains to be examined critically. Defining soils and conditions when N or Cd first becomes the limiting factor on sludge application rates should enhance the usefulness of guidelines for waste disposal on named kinds of soils.

Joe Kubota, Chairman
B. L. Carlile
D. E. Hill
G. J. Holmgren
L. J. Lund

REFERENCES

1. Boswell, F. C. 1975. Municipal sewage sludge and selected element applications to soil: Effect on soil and fescue. J. Environ. Qual. 4:267-273.

2. Chaney, R. L., M. C. White, and P. W. Simon. Plant uptake of heavy metals from sewage sludge applied to land. Proc. Joint Conference on Recycling Municipal Sludges and Effluent on Land. Champaign, IL. PP. 169-177.

3. Dowdy, Fi. H. and W. E. Larson. 1975. The availability of sludge-borne metals to various vegetable crops. J. Environ. Qual. 4:278-282.

4. Giordano, P. M., J. J. Mortvedt, and D. A. Mays. 1975. Effect of municipal wastes on crop yields and uptake of heavy metals. J. Environ. Qual. 4:394-399.

5. Jones, R. L., T. D. Hinesly, E. L. Ziegler, and J. J. Tyler. 1975. Cadmium and zinc contents of corn leaf and grain produced by sludge-amended soil. J. Environ. Qual. 4:509-514.

6. Kelling, W. A., D. R. Keeney, L. M. Walsh, and J. A. Ryan. A field study of the agricultural use of sewage sludge. III. Effect on uptake and extractability of sludge-borne metals (submitted for publication).

7. Sabey, B. R. and W. E. Hart. 1975. Land application of sewage sludge: I. Effect on growth and chemical composition of plants. J. Environ. Qual. 4:252-256.

Table 1. Sources of information used to assess sewage sludge disposal on named kinds of soils

State and reference	Kind of soil and family	Series	Properties		
			pH	CEC	Carbonates
AL[4]*	cosi, sil, th; Glossic Fragiudult	Sango sil	5.4	(low)	--
CO[7]	(colo, m, m; Udic Argiustoll)†	Truckton ls	--	5.2	(calc)
GA1	(c, kao, th; Rhodic Paleudult, oxidic)	Davidson cl	5.3	5.1	--
IL5	(f, ill, m; Aeric Ochraqualf)	Blount sil	5.4	(15-20)	(subsoil)
MD[2]	(fl, sil, m; Aquic Hapludult)	Woodstown sil	6.0	--	--
	(fl, sil, m; Typic Hapludalf)	Sassafras sil	—	—	--
MN3	s, m; Udorthentic Haploboroll	Hubbard cos	6.5	--	(subsoil)
WI[6]	fsi, m, m; Typic Argiudoll	Plano sil	6.0	22	(subsoil)
	fl/s, m, m; Typic Argiudoll	Warsaw sl	6.1	13	(subsoil)

*Reference number.

†Parentheses gives information from sources other than original publication.

Table 2. Zinc/Cd ratios for corn leaves and forage in relation to sludge loading rates (maximum) and plant concentration (median) of Zn and Cd

Source	Observations (average)	Zinc		Cadmium		Zn/Cd ratio
		Loading rate (maximum)	Concen. (median)	Loading rate (maximum)	Concen. (median)	
		kg/ha	ppm	kg/ha	ppm	
MI - corn leaves	4	450	123	3.3	0.44	299
WI - corn forage	30	180	32	4.3	0.15	216
IL - corn leaves	8	1204	146	59.2	1.71	a5
MD - corn leaves	16	645	139	4.8	1.82	63
AL - corn forage	4	651	95	10.0	3.6	26

FIGURE CAPTIONS

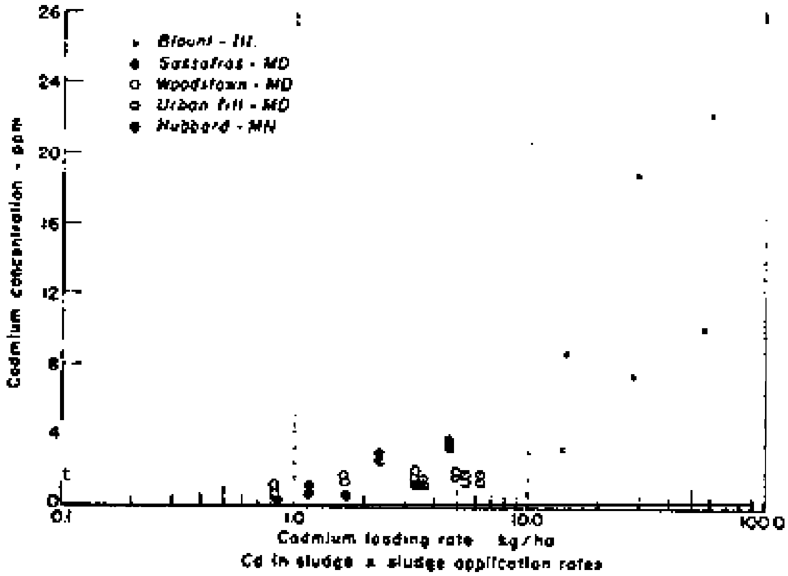
Fig. 1. Relationship of Cd concentration in corn leaf to Cd loading rate.

Fig. 2. Relationship of Zn concentration in corn leaf and corn stover to Zn loading rate.

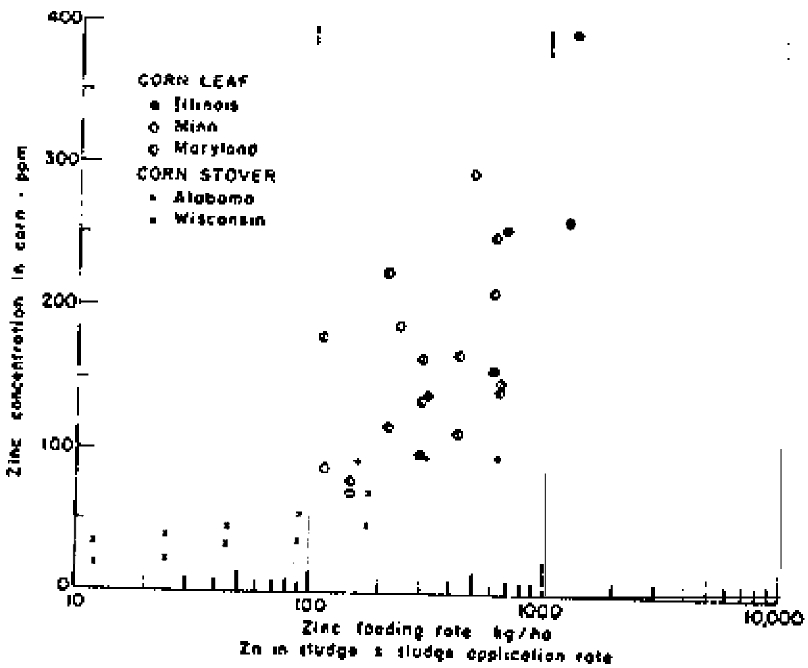
Fig. 3. Relationship of Zn leaf concentration to Zn loading rate of corn grown on three soils of Minnesota, Maryland and Illinois.

Fig. 4. Cadmium concentration in successive crops of corn (stover) following sewage sludge application on two Wisconsin soils.

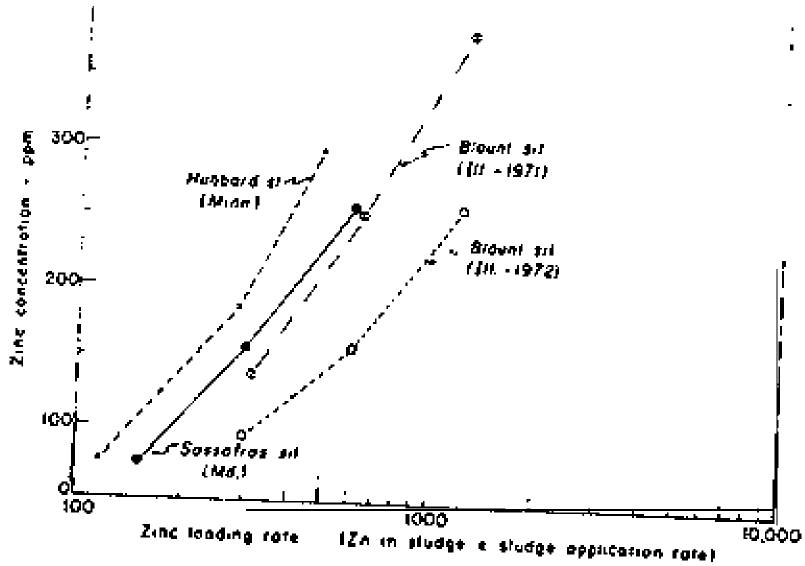
Fig. 5. Zinc concentration in successive crops of corn (stover) following sewage sludge application on two Wisconsin soils.

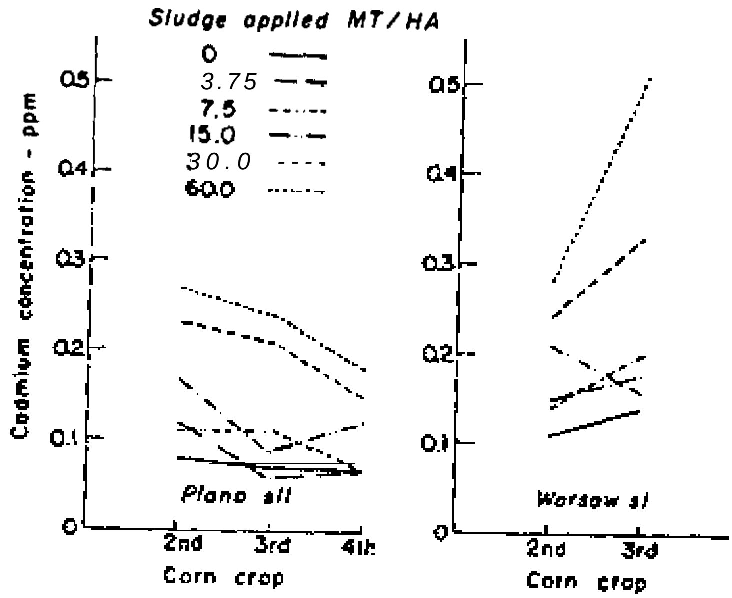


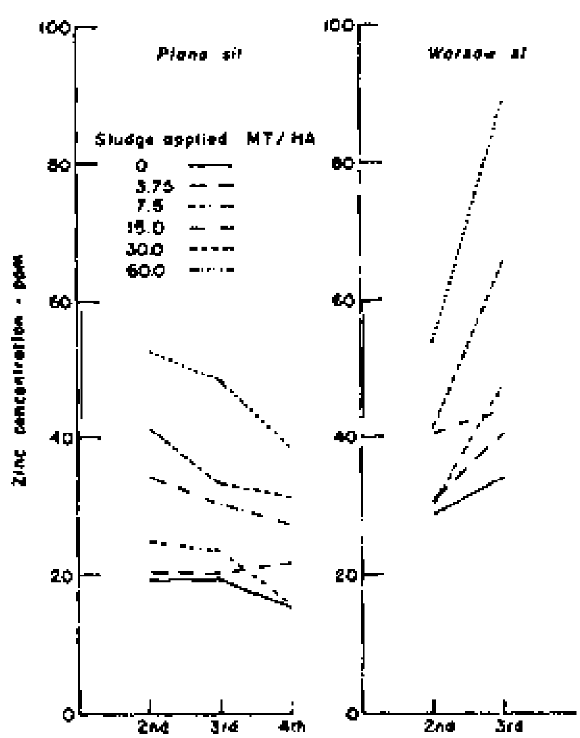
Blount - Ill.
Sassafras - MD
Woodstown - MD
Urban fill - MD
Hubbard - MN
Cadmium concentration - ppm
Cadmium loading rate kg/ha
Cd in sludge x sludge application rates



CORN LEAF
Illinois
Minn
Maryland
CORN STOVER
Alabama
Wisconsin
Zinc concentration in corn - ppm
Zinc loading rate kg/ha
Zn in sludge x sludge application rate


Zinc concentration - ppm
300
200
100
0
100
1000
10,000
Zinc loading rate (Zn in sludge x sludge application rate)
Hubbard sl (Minn)
Blount sil (Ill - 1971)
Blount sil (Ill. - 1972)
Sassafras sil (Md.)


Sludge applied MT/HA
0
3.75
7.5
15.0
30.0
60.0
Cadmium concentration - ppm
0.5
0.4
0.3
0.2
0.1
0
Plano sil
2nd
3rd
4th
Corn crop
Warsaw sl
2nd
3rd
Corn crop


Plano sil
Warsaw sl
Sludge applied MT/HA
0
3.75
7.5
15.0
30.0
60.0
Zinc concentration - ppm
100
80
60
40
20
0
2nd
3rd
4th
Corn crop
2nd
3rd
Corn crop

COMMITTEE 3 -- WASTE DISPOSAL ON NAMED KINDS OF SOILS

Work Group III. Methods of Analysis for Heavy Metals in Sewage Sludge

Soils and sludges may be characterized for heavy metals by total or extract analysis. Total analysis of sludges usually involves ashing at 450° C or wet digestion in oxidizing acids (5). Total analysis of soils requires prior dissolution in sodium carbonate or hydrofluoric acid. Cadmium may be volatilized during dry ashing and should be released by wet digestion or acid extraction (5). Bradford et al. (1, 2) have used prolonged digestion in 4 N nitric acid to approximate total metals in both soils and sludges.

Wear and Sumner (8) used 0.1 N HCl as a heavy metal extractant for soils. This extract has been used to characterize soils and sludges with good results (3, 7). This extract approximates total analysis for sludges but yields a lesser fraction for soils.

A third general class of extractants includes various chelating agents. These are presumed to be more selective for the readily available forms of the metals. Of these chelating agents, EDTA (6) and DTPA (4) have proven the most popular.

No one analytical approach can satisfactorily characterize soils and sludges for all purposes. Total analysis is the most conservative basis for calculating recommended loading rates on land. Strong acid (4 N HNO_3) or weak acid (0.1 N HCl) extracts closely approximate total analysis of sludge for many elements and should be satisfactory for most purposes. The various chelate extracts may be useful for plant uptake correlation studies but should not be used to calculate loading rates. Specific recommendations for analysis of the various elements are included in Kansas State Research Publication 170 (5).

References

1. Bradford, G. R., R. J. Arkley, P. F. Pratt, and F. L. Bair. 1967. Total content of nine mineral elements in fifty selected benchmark soil profiles of California. Hilgardia 38(4):541-556.

2. Bradford, G. Pi., A. L. Page, L. J. Lund, and W. Olmstead. 1975. Trace element concentrations of sewage treatment plant effluents and sludges; their interaction with soils and uptake by plants. J. Environ. Qual. 4:123-127.

3. Jones, R. L., T. D. Hinesly, E. L. Ziegler. 1973. Cadmium content of soybeans grown in sewage-sludge amended soil. J. Environ. Qual. 2:351-353.

4. Lindsay, W. L. 1972. Zinc in soils and plant nutrition. Advance. Agron. 24:147-186.

5. Kansas State University. 1975. Sampling and analysis of soils, plants, waste waters, and sludge. NE-118 Technical Subcommittee, Kansas State Univ. Res. Pub. 170.

6. Trierweiler, J. F. and W. L. Lindsay. 1969. EDTA-ammonium carbonate soil test for zinc. Soil sci. Soc. Amer. Proc. 3:49-54.

7. Walsh, L. M., W. H. Earhardt, and H. D. Serbel. 1972. Copper toxicity in snapbeans (Phaseolus vulgaris). J. Environ. Qual. 1:197-200.

8. Weir, J. I. and A. L. Sumner. 1948. Acid extractable zinc of soils in relation to the occurrence of zinc deficiency symptoms of corn: A method of analysis. Soil Sci. Soc. Amer. Proc. 12:143-144.

NATIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

January 31-February 4, 1977
Orlando, Florida

Report of Committee 4 - Water Movement in the Soils Landscape

CHARGES

1. Review models for water budgets of soil pedons and soil landscapes as they relate to pollution by sediments, pesticides, and fertilizer elements.

2. Establish how soil information is used in these models, whether the information presently provided for named kinds of soils is adequate, and what soil parameters must be better identified.

3. Consider the possible use of AMS and remote sensing techniques in interfacing soil survey information with models of waste movement in soils.

Hydrologic modeling was reviewed in considerable detail by soil moisture committees of the Western and North Central Soil Survey Work Planning Conferences of 1976. It was also treated by the 1975 report of this national committee, which was the basis for the above charges. For greater detail, particularly regarding the USDAHL-74 model, the reader is referred to those reports and to attachments to this report.

This report explores current and potential uses of Soil Survey information in hydrologic models. The models are intended to predict and describe moisture movement in soils and across landscapes. This is a growing need basic to many aspects of land use, soil and water conservation. Many models utilize little soil survey or other basic soils information. In some cases the modelers lack knowledge of available information. In other cases the available information is difficult to put into mathematical form.

Because soils maps and attendant Soil Survey interpretations put information into a detailed geographic format. the potential use in hydrologic modeling is great. Evaluation of form and content for applicability to modeling requirements was divided in two parts. One part, consideration of analytical techniques relating to infiltration and water movement was evaluated in detail. The second part, consideration of mapping unit and landscape descriptions, and other topographic information was deferred to a later committee.

Recommendations of this committee specifically refer to models, but when implemented they will also help with other water related use and management concerns including solid and liquid waste disposal, soil water storage, runoff and erosion, and movement of potential pollutants.

Hydrologic Models

Five models reviewed were: USDAHL-74, ACTMO, USBR Model, HYMO, and ARM. Their use is summarized in the main body and is discussed in more detail in attachments to this report. USDAHL-74 is a" ARS model for surface runoff, evapotranspiration, and groundwater recharge prediction based on a moisture accounting scheme. It has no capability for sediment yield, erosion, or chemical transport. ACTMO, also being developed by the ARS, incorporates USDAHL-74 and the USLE (universal soil loss equation) in a chemical transport model. This model calculates surface runoff, evapotranspiration, groundwater recharge, sediment yield, erosion, deposition, chemical transformations, and loss of chemicals through runoff and leaching. The USBR model simulates evapotranspiration, unsaturated flow, saturated flow, precipitation of slightly soluble salts, ion exchange, ion pairing, nitrogen transformations, crop uptake of nitrogen, movement and redistributions of salts and nutrients and predicts the concentration of Ca, Mg, Na, NH_4, HC03, C03, Cl, SO_4, NO_3-N, Urea-N, in the soil, the aquifer, and in drainage waters. This physical model has no provisions for surface runoff or erosion, or chemical losses through these processes. HYMO is a model developed by the ARS to estimate surface runoff and sediment yield from watersheds. It has no provisions for chemical transport or evapotranspiration or drainage. It is based on curve numbers available in the SCS National Engineering Handbook. ARM is a model developed by Hydrocomp Corporation for EPA. It simulates runoff, snow accumulation and melt, sediment loss, pesticide-soil interactions, and soil nutrient transformations and predicts sediment, pesticide, and nutrient content of runoff from small agricultural watersheds. It must be calibrated to a particular location as the hydrologic processes are largely empirical.

The models vary widely in their need for soil data. HYMO requires only soil erodibility factor (from USLE) values and rainfall-runoff curves found in the SCS National Engineering Handbook. On the other hand, the USBR model requires very detailed soils information including bulk density, unsaturated hydraulic conductivity as a function of water content, saturated hydraulic conductivity, moisture retention curves, soil temperature as a function of depth and time, cations, anions, pH, CEC, gypsum, carbonates, and carbon nitrogen ratio. Most models require bulk density, 1/3 and 15 bar water contents, and some estimate of infiltration. Some models require an estimate of cracking and/or surface conditions.

The reason for the wide variation in the amount of soils data needed for the various models lies in the nature of the model. The USBR model requires extensive soils data because it is a physical model using equations describing physical processes actually occurring. Conversely ARM requires only limited soils data (bulk density and an estimate of mea" infiltration rate), because it is an empirical model which must be calibrated with observations in any area where it is to be used. On the other hand, USDAHL-74 is a deterministic model which attempts to model soil processes by relating them to soil properties which have some degree of influence on them (e.g. most soil-water processes are represented as exhaustion functions of "available water capacity").

The soils information now provided is adequate for some models. The most needed additional values are infiltration rate, complete moisture retention curves, and unsaturated hydraulic conductivities.

AMS (Advanced Mapping System)

Computer storage of soils maps could be of obvious value for predictions of water movement in landscapes when tied into models such as the USDAHL-74. However, the full potential will require another generation of models designed to take advantage of more topographic detail. We should remain abreast of developments as this system progresses.

Remote Sensing of Soil Moisture

The greatest apparent usefulness of remote sensing to waste movement models is the potential for accurate determination of soil moisture content. With the present technology, it is possible to obtain a reasonable estimate of soil moisture in the surface 15 cm (6 in.). The effective depth is influenced by both surface roughness and soil moisture content. This is not deep enough to be of any direct benefit to models unless correlated to other soil moisture and climatic information. The existence of valid correlations remains to be demonstrated. However, a surface measurement of soil moisture could be useful in monitoring spatial distribution of rainfall, thus improving the accuracy and utility of models incorporating weather data in water balance type equations. For this purpose, the present 18-day data collection interval would have to be shortened considerably.

No one knows how long it will take to develop the technology to determine soil moisture at greater depths or even if it will be possible using remote sensing techniques. It is presently possible to determine plant stress, which is an indication of water availability in the root zone. It might be wise to encourage researchers to explore the possibilities of determining soil water using plant stress data. Advantages of this method are that the technology is available now and that it would give water content in the root zone where it is most important. Before this method can be used routinely, further research is needed to correlate remote sensing data on plant stress with soil moisture. Information on rooting patterns of specific plants in various soils is also needed for this method. The obvious disadvantage of this technique is the inability to determine soil moisture when the soil is bare or the vegetation dormant. Consideration also must be given to several factors such as the dependence of plant stress upon time of day and weather conditions, and the variation in root distribution over the growing season. This determination, unlike surface soil moisture determinations, is affected by cloud cover. No doubt, it will be desirable to use both methods together to obtain a more complete picture of soil water distribution.

Remote sensing is a potentially useful tool which we should continue to watch, but which is not sufficiently developed for "se within the scope of this report.

Summary and Comment

The mathematical description of water movement in soil landscapes is widely used to predict runoff, infiltration and soil water storage for agricultural uses and other water management purposes. It is used to predict erosion, stream pollution, aquifer pollution and potential impacts of alternate land uses.

A detailed model is limited in its usefulness if needed soils data are not available. Currently, soil survey data pertinent to models are available in one of two forms. One is the interpretive tables, pedon descriptions, and mapping unit descriptions and maps of soil surveys. The other is the published analytical data such as Soil Survey Investigations Reports. Soil surveys contain information regarding the distribution of soils in the landscape, horizontal and vertical variability of soils, and estimates of permeability, available water capacity, and runoff. Soil Survey Investigations Reports contain detailed data on bulk density, 1/3- and 15-bar moisture, water retention difference (WRD), and coefficient of linear extensibility (COLE) and non-numerical estimates of relative permeability and runoff . The estimates of permeability and runoff are of limited value to model users who need numerical values.

The more thorough mathematical statements require information that is not available through the soil survey program. There is a growing body of needed information accumulating in nonuniform and unorganized fashion. To take advantage of this existing information and to accumulate more in consistent and pertinent format will require us to cooperate closely with the people now working in hydrology and soil moisture fields. The effort is too complex for a single discipline, and too important to delay.

The amount of water entering the soil in a given situation is one of the most critical factors. The actual entry into the soil is controlled by surface and internal conditions that are very difficult to treat theoretically. Soils do not wet uniformly by saturated flow. Normally only the surface connected cracks and channels and a small proportion of the pores conduct water by saturated flow and these are often irregularly distributed when viewed in small sampling units. Therefore, soil moisture measurements on laboratory-sized samples are inadequate as bases for statements of infiltration rates. Field measurements of pedon size and larger are needed, along with shrink-swell information, and dry and moist descriptions of structure.

Soil moisture and soil surface conditions are transient. Any given soil will have a range of infiltration rates which change with moisture content and with immediate physical history of the given site. Field measurements of infiltration must be designed to give meaningful estimates of those ranges. As a minimum, infiltration should be measured at a dominant physcial condition with low initial moisture, and after prolonged heavy rain. Description of the surface morphology at infiltration measurement sites and as part of standard soil descriptions would assist in extending information.

Much soil water movement above water tables is by unsaturated flow at the wet end of the moisture range. This flow is through finer pores than is saturated flow, and can be adequately sampled in large cores (10-20 inch diameter) taken to the laboratory. The relationship between water content and rate of water movement is needed down to about the rate water moves at field capacity, which is roughly 0.01 cm per day. The data are needed for major horizons and for possible restrictive horizons even though the latter may be quite thin.

<u>Recommendations</u>

(1) The Soil Survey program incorporate methods to more thoroughly characterize soil water movement and water retention on a select range of important soils, including:

(a) data to create curves of hydraulic conductivities vs. water content from saturation to conductivities of roughly 0.01 cm/day, on the surface horizon, the first restricting horizon and the most limiting horizon within the depth to which our maps apply,

(b) infiltration measurements to establish the dominant range plus a minimum rate under poor surface physical conditions,

(2) Incorporate into standard pedon descriptions the observed surface conditions including cracks, crusts, structural differences from the remainder of the surface horizon, porosity, ranges and proportions of surface features across the pedon. Remind soil scientists through technical notes that careful descriptions of root distributions are important and are integral parts of detailed pedon descriptions.

(3) Add to pedon descriptions of benchmark soils,

(a) description of wettest condition and season(s) of occurrence,

(b) description of driest condition and season(s) of occurrence,

(4) Initiate a program to consolidate existing ARS and Experiment Station data pertaining to Item 1 above. This should be limited to information that is identified by kind of soil,

(5) Initially restrict the recommended soil characterization and consolidation of data to key soils. The goal is to characterize an array of key soils by the more thorough methods, and extrapolate through correlations with more widely available data,

(6) Present the recommended data in special reports and publications such as Soil Survey Investigations Reports,

(7) Elicit assistance from the Agricultural Research Service in designing a standard set of procedures.. Explore ways to develop an integrated national program with participation by cooperating agencies and the Agricultural Research Service,

(8) For the next conference charge this committee with

(a) reviewing progress and determining whether and how to incorporate the added information into standard interpretive tables,

(b) reviewing Progress in remote sensing and AMS for possible application to definition of water movement and soil moisture regimes across landscapes, and

(c) evaluating mapping unit descriptions and other Soil Survey information about distributions, shapes of soil bodies, slope lengths, positions and other topographic information for use in viewing and modeling soil water movement on a landscape-wide basis. Particularly, we should arrange our descriptive information to center attention on the mapping units and maps rather than on taxonomic units,

(9) Continue this committee.

<u>Discussion</u>

Peters - The Bureau of Reclamation has a committee reviewing the USBR model and will soon have a report discussing it.

Daniels - This committee should consider landscape relationships, distributions, and interactions of adjacent features.

Flach - This is one thing lacking in this report.

Holzhey - On this we agree. The committee purposely concentrated on a range of subject matter it could treat effectively at this conference. One of our recommendations is to look at the mapping units and landscape information for the next conference.

Wilding - Did you consider hysteresis and cracking in soils that shrink and swell?

Holzhey - I don't believe the current models handle cracking adequately. The hysteresis effects are very difficult to treat mathematically. Until the models get to that stage they should at least have information to tag these as soils with very slow infiltration when wet and very fast infiltration when dry.

Daniels - We can best influence models and concepts by working with the Agricultural Research Service and others who are doing developmental work.

Holzhey - This was begun in the cooperative effort with the Hydrograph Laboratory, ARS, Beltsville. That project hit a lot of snags, but the idea of such joint work should be pursued. This committee's proposals are based on the hope of active interagency participation including ARS and Experiment Stations.

McCormack - Perhaps infiltration studies should be done mostly to test working hypotheses.

Grossman - It may not necessarily require that much limitation. We should take advantage of existing facilities to make infiltration measurements.

Holzhey - We should also use existing data.

Flach - Sometimes it is not too valuable to gather data accumulated by different methods. We have to be careful to allocate our time in ways that will give us useable information.

Wilding - Experiment Stations and ARS facilities don't always have the soils of interest.

Flach - ARS watershed selection was quite an objective effort.

Wilding - There are still gaps.

Grossman - Nevertheless the ARS watersheds are where you get runoff information and can interface with ARS people.

Flach - ARS is willing to work with us.

Smith - We should consider roots in the information we provide.

Holzhey - We recommend more consistent attention to this in standard pedon descriptions.

Flach - We need more observations about root distributions. Does the Forest Service have these observations?

Larsen - Tie pay attention to drainage patterns, dissection, slope, hydrology and drainage net.

Flach - Walter Lyford's studies showed that roots go beyond pedons.

Meier - The Forest Service has some such studies, but not integrated into hydrology.

Holzhey - Rooting patterns are often the single most connotative factor relative to saturated flow in woodlands.

Miller - There are some University of Wisconsin studies that are detailed and useful to look at.

Flach - This has influenced much current thinking.

Fenton - We have to be careful in recommendations that refer to "named kinds of soils." Phases are sometimes as important as series.

Question (unidentified participant) Who would do the work you propose?

Holzhey - There is equipment at many ARS and Experiment Station locations. We will encourage a program to get infiltration data by cooperative efforts with these institutions. The National Soil Survey Laboratory can do unsaturated hydraulic conductivity measurements with equipment developed by Grossman and Amerman.

Committee Members

C. Steven Holzhey - Chairman

R. Boyce
F. J. Carlisle, Jr.
Wayne Chapman
George H. Comer
J. M. Davidson
Erling Gamble
R. B. Grossman
J. W. Hawley
A. R. Hidlebaugh
R. D. Heil
J. N. Holeman
F. S. Newhall
R. F. Paetzold
David S. Ralston
A. S. Rogowski
E. H. Sautter
M. E. Shaffer
D. E. Snyder
M. Stout, Jr.
B. A. Touchet

Selected References

1. Aase, J. K., J. R. Wight and F. H. Siddoway. 1973. Estimating soil water content on native rangeland. Agri. Meteorology 12:185-191.

2. ARS. 1975. Present and prospective technology for predicting sediment yields and sources. Proceedings Sediment-Yield Workshop. USDA Sed. Lab., Oxford, Miss., Nov. 28-30, 1972. USDA-ARS. ARS-S-40.

3. Batlivala, P. P. and F. T. Ulaby. 1976. Remotely sensing soil moisture with radar. RSL Tech. Report 264-8, Univ. of Kansas Center for Research.

4. Batlivala, P. P. and C. Dobson. 1976. Soil moisture experiment (Kansas): Documentation of radar backscatter and ground truth data. RSL Tech. Report 264-7, Univ. of Kansas Center for Research.

5. Boast, C. W. 1973. Modeling the movement of chemicals in soils by water. Soil Sci. 115:224-230.

6. Donigian, Jr., A. S. and N. H. Crawford. 1976. Modeling pesticides and nutrients on agricultural lands. USEPA. EPA-60012-76-043.

7. Eagleman, J. R., E. C. Pogge and R. K. Moore. 1975. Detection of soil moisture and snow characteristics from Skylab. center for Research, Univ. of Kansas. EREP No. 540-A2.

8. England, C. B. 1975. Soil moisture accounting component of the USDAHL-74 model of watershed hydrology. Wat. Res. Bul. 11:559-567.

9. Engman, E. T. and A. S. Rogowski. 1974. Selection of soil moisture parameters for synthesizing storm hydrographs. ASAE Meeting on Wat. Res. Eng. Preprint 2127.

10. Frere, M. H. 1973. Adsorption and transport of agricultural chemicals in watersheds. Trans. ASAE 16:569-577.

11. Frere, M. H., C. A. Onstad, and H. N. Holtan. 1975. ACTMO, An agricultural chemical transport model. USDA-ARS. ARS-H-3.

12. Gardner, W. R. 1965. Movement of nitrogen in soil. In W. V. Bartholomew and Francis E. Clark (ed.) Soil nitrogen. Agronomy 10: 550-572. Amer. Soc. Agron., Madison, Wis.

13. Henninger, D. L., G. W. Petersen and E. T. Engman. 1976. Surface soil moisture within a watershed--variations, factors influencing, and relationship to surface runoff. Soil Sci. Soc. Amer. Journal 40:773-776.

14. Holtan, H. N., G. J. Stiltner. W. H. Henson, and N. C. Lopez. 1975. USDAHL-74. Revised model of watershed hydrology. USDA-ARS. Tech. Bul. No. 1518.

15. James, L. D. 1972. Hydrologic modeling, parameter estimation and watershed characteristic&. J. Hydrology 17:283-307.

16. Jensen, M. E., J. L. Wright, and B. J. Pratt. 1971. Estimating soil moisture depletion from climate, crop and soil data. Trans. Amer. Soc. Agri. Eng. 954-959.

17. Kurtz, L. T. and S. W. Melsted. 1973. Movement of chemicals in soils by water. Soil Sci. 115:231-239.

18. Leistra, M. 1973. Computation models for the transport of pesticides in soil. Residue Rev. 49:87-130.

19. Reginato, R. J., S. B. Idso, and R. D. Jackson. 1975. Assessing soil moisture remotely. Hydrology and Water Resources in Arizona and the Southwest. Proceed. 1975 Meetings Ariz. Sec. Amer. Water Kes. hssn. and Hydrology Sec. Ariz. Acad. of Sci. 5:191-198.

20. Ribbens, R. W. and M. J. Shaffer. 1976. Irrigation return flow modeling for the Souris loop. Spec. Conf. "Environ. Aspects of It-rig. and Drain." Amer. Soc. Civil Eng.

21. Richardson, C. W. and J. T. Ritchie. 1973. Soil water balance for small watersheds. Trans. ASAE 16:72-77.

22. Saxton, K. E., H. P. Johnson, and R. H. Shaw. 1974. Watershed evapotranspiration estimated by the combination method. Trans. ASAE 17: 668-672.

23. Saxton, K. E., H. P. Johnson, and R. H. Shaw. 1974. Modeling evapotranspiration and soil moisture. Trans. ASAE 17:673-677.

24. Shaffer, M. J., R. W. Ribbens, and C. W. Huntley. 1975. Detailed return flow salinity and nutrient simulation model. Vol. v. Prediction of mineral quality of irrigation return flow. U.S. Bureau of Reclamation. EPA-IAG-D4-0371.

25. Shaffer, M. J. 1976. Detailed return flow salinity and nutrient simulation model. Proc. Int. Conf. Managing saline water for irrigation: Planning for the future. Lubbock, Texas.

26. Shawcroft, R. W., E. R. Lemon, L. H. Allen, Jr., D. W. Stewart and S. E. Jensen. 1974. The soil-plant-atmosphere model and some of its predictions. Agri. Meteorology 14:287-307.

27. Silva, L. F., F. V. Schultz. and J. T. Zalusky. 1974. Electrical methods of determining soil moisture content. LARS Info Note 112174. Purdue University.

28. vanKeulen, H. and C.G.E.M. vanBeek. 1971. Water movement in layered soils--A simulation model. Neth. J. Agric. Sci. 19:138-153.

29. Williams, J. R. and R. W. Hann, Jr. 1973. HYMO: Problem-oriented computer language for hydrologic modeling. Users Manual. USDA-ARS. ARS-S-9.

30. Woolhiser, D. A. 1973. Hydrologic and watershed modeling--state of the art. Trans. ASAE 16:553-559.

Attachments

Attachment 1 consists of some additional notes on the five hydrologic models studied in this report. These models were chosen because they are among the most used models and they represent a diversity of types, i.e. large scale, small scale, highly detailed and general.

Attachment 2 illustrates the range in unsaturated hydraulic conductivity values of various materials. Unsaturated conditions persist in most soils and most water movement occurs under these conditions. Most water movement that is of importance occurs under conditions of water contents greater than about 1/3 bar. Saturated hydraulic conductivity is important in a few special situations such as during irrigation, disposal of waste water, and in soils with high water tables. Differences between hydraulic conductivity at saturation and at a water content a few percent lower are commonly 1000 fold or more. Evaluation of moisture movement in soils requires both saturated and unsaturated hydraulic conductivity.

Excerpts from the North Central Regional Soil Survey Work Planning Conference are in attachment 3. Much of the groundwork for the recommendations contained in this report was laid by the North Central Committee.

ATTACHMENT 1

Notes on Models

USDAHL-74 (United States Department of Agriculture Hydrograph Laboratory, version of 1974)

Primarily to predict runoff for watershed engineering purposes.

Soils Input - Bulk density (1/3 bar and dry) for surface and subsurface layers
- 1/3 bar moisture and WRD or 15 bar moisture for surface and subsurface layers
- "a" factor (index of surface connected porosity) for infiltration
- Constant rate of infiltration after prolonged wetting (from SCS National Engineering Handbook)

ACTMO (Agricultural Chemical Transport Model)

Accounting model incorporating USDAHL-74 for watershed hydrology and Universal Soil Loss Equation (USLE) for erosion. Computes erosion, fate of chemicals (primarily pesticides and fertilizers), and watershed hydrology.

Soils Input - Same as USDAHL-74 plus
- Soil erodibility factor
- Texture

U.S. Bureau of Reclamation Model

Models plant-soil-aquifer system from soil surface to a tile or open drain. Does not compute runoff or erosion.

Soils Input - Saturated hydraulic conductivities
- Bulk density and total porosity
- Unsaturated hydraulic conductivity as a function of soil water content (calculated from Millington and Quirk equation using moisture release curve if unsaturated hydraulic conductivity curve not available)
- Moisture release curve
- Soil temperature as a function of depth and time
- Chemical data
  - Cations
  - Anions
  - pH
  - CEC
  - Gypsum
  - Carbon/nitrogen ratio

HYMO (Hydrologic Model)

Models surface runoff and sediment yield from watersheds using USLE

Soils Input - Soil erodibility factor
- Rainfall-runoff relationships from numbered curves in SCS National Engineering Handbook

ARM (Agricultural Runoff Model)

Developed from PTR, Pesticide Transport and Runoff Model for US-EPA BY Hydrocomp. Simulates runoff, snow accumulation and melt, sediment loss, pesticide-soil interactions, and soil nutrient transformations (sediment, pesticide, and nutrient content of runoff from small agricultural watersheds). Model must be calibrated to each specific watershed.

Soils Input - Bulk density
Mean infiltration rate

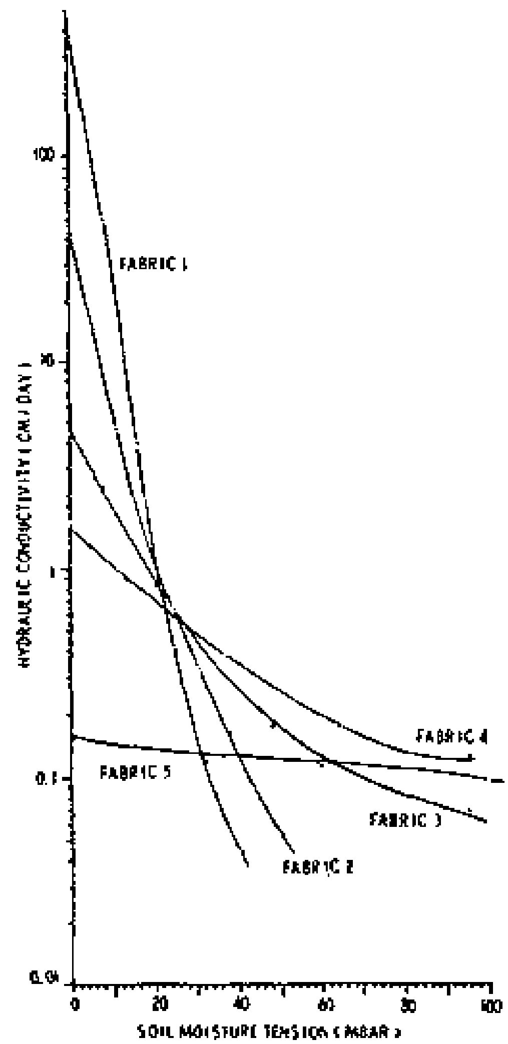


Figure 8. Hydraulic conductivity characteristics for five basic structures.

From Bouma and Anderson

Soil Structure and Hydraulic Conductivity in Field Soil Water Regime ASA Special Pub. No. 5 p 96

NORTH CENTRAL REGIONAL
TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

ATTACHMENT 3

Traverse City, Michigan
May 3-7, 1976

REPORT OF COMMITTEE 4 - WATER RELATIONS IN SOILS

Committee Charge:

Consider the question, "How can the soil survey contribute to, and benefit by, hydrologic modelling?"

It was recommended by Committee 4 of the 1975 National Soil Survey Conference that regional conferences give major emphasis to the application of hydrologic models. (See Page 207 of the Proceedings)

Committee Approach:

It appeared to the Committee that the future quality of the understanding and the interpretation of soils might be determined by how well the soil survey foresees the kinds of soils information that will be required for accurate hydrologic models. The need appeared to be that members of Committee 4 become more familiar with hydrologic models and with soils inputs. With that need in mind, a seminar type approach was arranged for the Traverse City meeting. The outline for the seminar was as follows:

Part I. Quantitative-Input Needs for Hydrologic Modelling.

Keith Saxton, Research Hydraulic Engineer,
A.R.S. Columbia, Missouri

Part II. A Review of the USDAHL-74 Model of Watershed Hydrology.

This review was accomplished in four parts, each centered around kinds of input parameters and each having a discussion leader.

Each discussion leader led discussion of 5 general questions:

(1) What parameters are in the model?
(2) What soils information is required?
(3) How does one obtain the needed soils information using current procedures?
(4) If information is not available, how can procedures be modified?
(5) Do other models require different input data?

A. Watershed Parameters - D.D. Malo - South Dakota State Univ.

Part 11 - (Continued)

B. Soil Parameters - R.B. Grossman - University of Missouri

C. Crop Parameters - Don Franzmeier - Purdue University

D. Hydrographs and Coefficients of Routing - Keith Saxton

Part III. Suggested Courses of Action - Dick Rust - University of Minnesota.

The report which follows does not contain the entirety of discussions and presentations. It focuses upon those points that appeared to be most pertinent to the committee charge.

Part I. Quantitative Input Needs for Hydrologic Modellinp.

The question "Why model?" was asked. Two important reasons are: (1) soil survey has new needs for determining where agricultural water is going and what is in the water; and (2) the rapid development of computer technology has released the new capabilities for modellinq which permits the inteqration of a large number of processes. The soil survey should use modelling in order to take advantage of the wealth of information that has accumulated.

Keith Saxton differentiated between hydraulic models and hydrologic models. Hydraulic models are concerned with the flow of water after it reaches streams. Hydrologic models are concerned with the manner in which water interacts with the soil-plant system in order to generate stream flow, or, in some cases, to result in no flow. Hydrology is the main focus and interest of the soil survey. The ARS program is focused upon hydrology.

Part IIA - Watershed Parameters.

In order to subdivide a watershed into some landscape units that groups soils, the USDAHL model identifies hydrologic response zones. The zones are essentially land capability units. This approach is questionable and it appears that the soil survey should explore the extent to which soil mapping units would be a better way to subdivide a watershed. It was thought that in some instances this approach would be fruitful. In other cases this would not be so because current mapping units were designed with a different objective in mind.

In order to improve our descriptions of watersheds or of mapping units, the soil survey should explore the possibility of identifying geomorphic surfaces or perhaps the hillslope model of Ruhe could be used to describe landscape position.

Part IIB - Soil Parameters.

Infiltration is the primary process that must be quantitatively described for soils for the USDAHL model or any other hydrologic model.

Soil layers in two positions appear to merit special consideration by the soil survey; First, the description of the immediate surface and its expected effect upon infiltration is needed. Crusting is an example. Plant cover affects this part of the soil. The "a" value of the USDAHL model is an initial step. The soil survey should be able to provide the modeller with improved "a" values or substitutes for it. The second kind of positional layer meriting attention is below the solum in landscapes where the particular layer restricts water movement to a greater degree than do overlying layers in the solum. This second-listed need will be particularly evident in those models of the future that will predict two-dimensional and three-dimensional flow patterns based upon the Darcy flow equation.

Part IIC - Crop Parameters.

Crop parameters are based upon GI (growth index) which describes the seasonal development of the plant canopy. To a large extent this index is based upon temperature.

The estimate of ET (evapotranspiration) is based upon pan evaporation. If pan evapotranspiration is to be used, it may be necessary to arrive at estimates of pan evapotranspiration as influenced by topography, landscape position or by slope aspect.

Rooting depth and rooting volumes need better descriptors.

Part IID - Routing Coefficients.

The USDAHL model requires an observed hydrograph from which streamflow contributions can be apportioned to overland flow, interflow and base flow. Such hydrographs are rare for small watersheds. Overland flow is predicted from precipitation excess. Predicted precipitation excess is strongly influenced by an "a" value which is a number describing surface conditions. This "a" value appears to encompass a large number of surface characteristics and it is felt that the soil survey should be able to improve upon this parameter.

Rydrographs and the resulting routing coefficients appear to be influenced by the stratification of materials below the solum. The soil survey may be able, from knowledge of climatic settings and stratigraphy of materials to estimate for the hydrologist the relative magnitudes of overland flow, interflow and base flow.

Keith Saxton presented his view, as a hydrologist of the soils information that would be needed for modelling of agricultural hydrology:

Desired Soil Information for Agricultural Hydrology

(1) Mapped soil units (soil map)
(2) Profile descriptions
(3) Water char. for major horizons

W.P.; F.C. Sat. vol. of water
Pressure vs. vol. of water
Conductivity vs. vol. of water

(4) Performance characteristics

crusting, cracking, drainage
root penetration, lateral seepage

(5) Geomorphic setting

surficial geology

(6) Erosion characteristics
(7) Chemical characteristics

The list suggested by Keith Saxton provided the basis for final discussion and for suggested courses of action. The terms, wilting point (W.P.), field capacity (F.C.) and available water were recognized as needing description in terms of water contents at stated water pressures.

Part III. Suggested Courses of Action.

As a result of Committee 4's discussions, several courses of action were suggested. The list of suggestions that follow is not arrayed in an order of importance. The list is divided into two categories: (1) those suggestions for actions that can be taker. rather quickly from our base of knowledge and (2) those courses of action that will require some additional effort in the direction of improved or changed procedures. This second category will be those areas in which the soil survey must move from qualitative to quantitative descriptions.

Courses of Action That Can Be Taken Rather Quickly.

(1) The soil survey can provide the hydrologist with map unit descriptions that will be useful in the delineation of hydrologic response zones.

(2) The soil survey can provide the hydrologist with profile descriptions that will enable him to decide upon a minimal number of soil horizons or depth increments that will be required for a reasonable analysis of infiltration.

(3) The soil survey can provide the hydrologist with estimated values of soil water characteristics

(a) available water by water retention difference
(b) a set of curves relating (1) water pressure and water volume:
(2) water conductivity and water volume;

with a first guess as to which curve is characteristic for any horizon.

(4) Bulk density estimates can be made so that the modeller can convert other estimates to volumes. The modeller can also use such estimates of bulk density to improve predictions of root penetration.

Courses of Action Requiring Additional Effort Toward Quantification.

(1) Performance characteristics of the soil, particularly the surface soil need to be described according to their changes with time, seasons, or particular use.

(2) Seasonal moisture conditions or states need to be quantitatively described by soil horizons.

(3) Root penetration needs to be related to morphological variability.

(4) Soils and geomorphology descriptions are needed on the 50 small watersheds that have the instrumentation required by hydrologists.

(5) The soil survey should encourage persons to try the USDAHL model to see if it works for them and to attempt our suggested modifications.

End of excerpt from North Central Work Planning Conference Committee 4.

NATIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

January 31 to February 4, 1977
Orlando, Florida

Committee No. 5 - Soil Surveys in Woodland, Rangeland, and Wildland

CHARGES:

1. Identify means for making useful interpretations of multi-taxa soil mapping units in Orders 3, 4, and 5 soil surveys, Prepare models.

2. Study the relationships between interpretive groupings such as range site, woodland site, ecological site, and soil mapping unit.

The committee was divided into three subcommittees to handle the charges as follows: Subcommittee SA Rangeland, Subcommittee SB Woodland, and Subcommittee SC Wildland.

The subcommittee reports are included in Attachments 2 and 3. Reports for Committees 7 and 8 of the Western Regional Work-Planning Conference are Attachments 4 and 5. Wildlife Task Force report for the Western Region is Attachment 6.

SUMMARY

Charge 1. The subcommittees agreed on the following:

1: It is absolutely necessary to have clear, concise, accurate, and complete descriptions of the mapping units. As outlined in the draft of Agricultural Handbook 18, this includes for soil association (a) principal and minor components, (b) the mapping inclusions, (c) relative proportions of each and their range among delineation, and (d) their geographic distribution or pattern.

2. The interpretations of soil associations require rating the individual kinds of soil and assessing the interaction of each one on the use, management, and performance of the others and on the association as a whole. The final interpretation should be for the association as a whole.

3. The design of the mapping units is multidisciplinary work requiring inputs from technical people in all fields concerned in the interpretation, use, and management of soils. Survey objectives will determine the survey order and the interpretive groupings are developed to meet these objectives.

Charge 2. Ecological sites and soil mapping units can be correlated.

RECOMMENDATIONS

1. The committee be retained.

2. The "Soil-Natural Vegetation Interpretations and Display" (Attachment 1) developed by E. Naphan, State Soil Scientist, Nevada, be given field trials. Regional Committees should again be urged to develop methods of display for interpretations of multi-taxa mapping units in Orders 3, 4, and 5 soil surveys.

3. The draft Chapters 6 and 11 of Soil Survey Manual Handbook 18, and Section 302, National Range Handbook be used in developing interpretations of multi-taxa mapping units.

4. The National and Regional Committees should be charged early and meet at least once before the scheduled planning conference.

RECOMMENDATIONS OF THE COMMITTEE. MEETING IN ORLANDO

The committee report was reviewed on Tuesday, February 1, 1977, by members of the committee attending the meeting and some members of the conference.

The following recommendations were made to the conference on Wednesday, February 2, 1977:

1. Charge 1.

   a. Agreed to the subcommittee's recommendation (1) for mapping unit descriptions.

      These must be more carefully written concerning components, inclusions, and geographic distribution and pattern. Guidelines for these descriptions to include interaction between components will be developed (E. A. Naphan, State Soil Scientist, Nevada, to take leadership in developing the outline).

   b. Interpretations for both components of the mapping unit and the mapping units as a whole can be made. Flexibility will be allowed regionally and interpretations may be either in tables or narrative or both; for example:

      (1) Rate mapping unit in a table and describe the components in the mapping unit description.

      (2) Rate both the components and the mapping unit in one table.

      (3) Rate mapping unit on one table and components on a separate table in appendix.

      (4) Ratings can be made by:

         (a) Averaging; i.e., yields
         (b) Cropland, rangeland, woodland
         (c) Community development rather than for houses, septic tanks, roads, etc.

      (5) Attachment 1, Subcommittee 5A, "Soil-Natural Vegetation Interpretations and Display," should be sent to state offices for trial.

2. Charge 2.

Change charge to read "Rate woodland, rangeland, and wildland for soil potential."

a. Soil potential is an additional summary of soil capabilities beyond those used for rangeland sites and woodland sites, and land capability. It is not intended that soil potential replace other groupings or ratings.

b. Soil potential ratings will array the soils in a survey area. They will not be correlated area to area.

c. Soil potential ratings should be given trials in all states with rangeland and woodland.

3. The regions should consider setting up committees to test the recommendations and to develop models.

4. The committee should be continued.

There was more discussion from the floor, but it did not alter the recommendations of the committee.

It was moved and seconded that the report be accepted; motion carried. It was also moved and seconded that the committee be continued; motion carried.

Committee Members

Richard C. Huff, Chairman, SCS, Honolulu, Hawaii
Kermit Larson, Co-chairman, FS. Arlington, Virginia
B. L. Allen .... Texas Tech University, Lubbock, Texas
L. L. Buller .... SCS, Lincoln, Nebraska
0. R. Carter .... SCS, Hyattsville, Maryland
J. A. Ferwerda .... SCS. Univ. of Maine, Orono, Maine
R. C. Carter .... SCS, Jackson, Mississippi
J. A. DeMent .... SCS, Fort Worth, Texas
L. D. Giese .... Dept. of Natural Resources, Olympia, Washington
V. K. Hugie .... SCS, Portland, Oregon
W. J. Lloyd .... SCS, Washington, D. C.
R. Meurisse .... FS. Portland. Oregon
L. D. Marriage .... SCS, Portland, Oregon
E. A. Naphan .... SCS, Reno, Nevada
J. Newman .... SCS, Lincoln, Nebraska
F. E. Otte .... SCS, Casper, Wyoming
D. T. Pendleton .... SCS, Washington, D. C.
W. J. Sauerwein .... SCS, Portland, Oregon
C. M. Thompson .... SCS, Temple, Texas

Planning Conference - NCSS
(Committee No. 5 use only)
USDA-SCS, Reno, Nevada
EAN: 11/76

SOIL-NATURAL VEGETATION INTERPRETATIONS AND DISPLAY
ORDER 3, 4 and 5 SOIL SURVEYS

Attachment 1
Subcommittee 5A

Kind of Soil Survey	Kind of Major Component Soils	Interpretations Concerned With Use of the Soil-Natural Vegetation Complex		
		Narrative Display		Tabular Displays for Component Soils (only for potential uses anticipated in forseeable future)
		For Component Soils (Map Unit Descriptions)	For Whole Map Unit (Map Unit Descriptions)	
Order 3	Phases of soil series and phases of soil families.	1. The potential plant community - ecological site. 2. Seral plant communities. 3. Use potentials for livestock grazing, wildlife habitat, woodland, recreation, other. 4. Management systems and practices for specified uses.	1. Use potentials for livestock grazing, wildlife habitat, woodland, recreation, other. 2. Management systems and practices for specified uses.	1. Potential range productivity and composition. 2. Woodland understory vegetation. 3. Woodland management and productivity. 4. Wildlife habitat potentials. 5. Recreational developments. 6. Physical and chemical properties of soils. 7. Soil and water features. 8. Engineering classification. (to include only USDA texture, percent > 3 inch and unified and AASHTO classification)
Order 4	Phases of soil families.	1. Potential plant community - ecological site. 2. Seral plant communities. 3. Use potentials for livestock grazing, wildlife habitat, woodland, recreation, other - if significantly contrasting.	1. Use potentials for livestock grazing, wildlife habitat, woodland, recreation, other. 2. Management systems and practices for specified uses.	1. Physical and chemical properties of soils. 2. Engineering classification. (to include only USDA texture, percent > 3 inch, and unified and AASHTO classification)
	Phases of subgroups.	1. Seral plant communities or vegetative types.	1. Use potentials for livestock grazing, wildlife habitat, woodland, recreation, other. 2. Management systems and practices for specified uses.	None.
Order 5	Phases of subgroups, great groups, suborders and orders.	1. Seral plant communities or vegetative types.	1. Use potentials for livestock grazing, wildlife habitat, woodland, recreation, other. 2. General management systems and practices for specified uses.	None.

SUBCOMMITTEE 5A - RANGELAND

Charge 1.

We have about agreed on how to develop the interpretations for the different orders, who the users will be, and the degree of detail to be included. The next step is to work with actual mapping examples of each order to develop example interpretations. This will help firm up degree of detail, problems, etc.

Order 5: This order will have little, if any, use in the United States for rangeland mapping. If it is used, an interpretation for rangeland could be developed, but would be limited to a general statement on the potential for rangeland and type of vegetation. For example, "The natural potential plant community in this unit is predominantly native grass, but varies from grassland interspersed with islands of brush and trees to a very sparse cover of short brush interspersed with pockets of grass. Potential uses are water production, wildlife habitat, and esthetics. Only limited areas are suitable for livestock grazing. Primary limitations are the lack of ground cover, limited forage production, and excessive variations in soil, plant communities, and topography within an area of practical management size." Users of this type of information would have to be interested in the first overview of the general development potential of a region.

Order 4: Limited use is anticipated. Nevada has used it in some areas. Alaska may have the most potential for use at this time. Interpretations could be more specific. For example, "This unit will support natural herbaceous and/or browse vegetation which are suitable for wildlife habitat 'if populations are controlled and other appropriate management practices are applied. Livestock use of the unit should be limited because of the limited forage production, excessive fluctuation of annual forage production, the competition with the natural wildlife populations and the potential soil erosion problems resulting from overgrazing." (The above examples are just a rough discourse to show degree of detail, they are not to be misconstrued as example interpretations.)

This type of survey could be utilized by regional planners, land use planners, state planners, and others concerned with the general use of the area. From a range management viewpoint, it would be most valuable for wildlife, esthetics, water yield, and watershed protection. It would have only limited use for livestock management.

Order 3: This is the intensity of soil surveying that corresponds very well with range sites (or ecological sites). Therefore, the users of interpretations in this order are the rangeland users and managers. Considerably more use and management detail could be included in the rangeland interpretations.

Although we have not reached a consensus on any model, a summary chart developed by a member is attached (Attachment 1). We agreed that if multi-taxa mapping units (Order 3) contain more than one range site, each component part should be interpreted as well as how one complements (positive or negative) the other if managed together. Also, prior to Order 3 mapping on rangeland, an interdisciplinary team should plan the mapping unit to satisfy the planning and management intensity related to the potential use. Naphan suggests that orders of mapping could be intermixed within a mapping area if the confidence level is clearly explained in the report.

Charge 2.

The Western States have vast areas of native vegetation that have use potentials that are limited to wildlife and recreation because of severe aridity and soil characteristics. They tend to favor use of ecological sites in lieu of range sites. The basic reasoning is that it eliminates implications associated with grazing use by livestock, and covers all natural vegetation in plant communities. In connection with considerations which might possibly lead to adoption of ecological sites in lieu of range sites, we would also urge that these be identified by naming the major dominant plants which characterize the potential plant community. Furthermore, identification of seral plant communities which are departures from the potential plant community would be useful.

Subcommittee 5A - Rangeland

P. L. Allen	E. A. Naphan
0. R. Carter	J. Newman, Chairman
V. K. Hugie	D. T. Pendleton

This is a report of the Woodland Subcommittee of Committee 5. I have attempted to synthesize and integrate the comments of the three members, who responded, with my own comments.

I am not satisfied that we have been able to provide adequate responses to the charges. Nor do I believe there is any one way to respond to these charges. It is my opinion that we may be trying too intensely to arrive at one simple approach to these lower order surveys when there are a number of ways that interpretations can be made. This applies to higher orders as well as Orders 3 through 5.

The most difficult concept for many of our field soil scientists to grasp is one of variability. To adequately describe the variability is difficult. The concept of variability becomes increasingly important with the lower orders. However, it is important at any order. (These statements assume a constant taxonomic level. That is, at higher taxonomic levels, the number of taxa may not increase with lower survey orders. Rather, ranges in characteristics of the soils and interpretive variability increase.)

With this as background, our response to the charges is as follows:

Charge 1. Identify means for making useful interpretations of multi-taxa soil mapping units for Order 3, 4, and 5 soil surveys.

The best way to make useful interpretations is to have clear, concise, and complete descriptions of the mapping unit. This includes percentage composition of the components and location or arrangement of the components on the landscape, in addition to a brief description of landform, climate, lithology, and plant association. These elements are also important in formation of the mapping unit, particularly in upland and forest and rangeland areas.

Interpretations must be developed for each of the important taxa within the mapping unit. Again, the interpretations must provide for measures of variability. These interpretations should be in two forms, as follows: (1) basic numerical data (i.e., site index, growth basal area, periodic annual increments, biomass, etc.) with standard deviations or coefficients of variation; and (2) qualitative ratings for utilitarian purposes (i.e., good, fair, poor or high, medium, low). The former is primarily for use by other scientists and preservation of basic data. The latter is for the other users of soil surveys. Perhaps the most important part of providing good qualitative ratings is to choose well-defined criteria for the variables and for interpretative groupings after ratings of the taxa have been made. These criteria should be made part of the report. The above statements are pertinent for any survey order, not just Orders 3, 4, and 5. In other words, it is important to recognize the variability and the exceptions to the generalities. If the percentage composition is given for each of the major taxa, and others, to total 100 percent, the user can readily determine the percent that is of a particular capability or potential.

Charge 2. Study the relationships between interpretive groupings and soil mapping units.

Since interpretive groupings are developed for utilitarian purposes, the objectives of the specific survey will influence the basis for groupings. Survey objectives will determine the survey order, not the reverse. Therefore, interpretive groupings can be readily developed to meet the objectives. Carefully developed groupings normally are valid for a multiple of purposes. Generally, there will be more groupings for higher order surveys than for lower orders.

Groupings based on sound, ecological considerations and with a consideration of local management and cultural practices should serve a variety of needs.

Regardless of the survey order, mapping units must be designed with survey objectives in mind, together with consideration of heterogeneity of the survey area. If these ingredients are thoroughly evaluated, groupings of like soils will follow rather easily.

General. It is my opinion that these charges have been discussed in sufficient detail to implement guidelines for conducting the various orders of survey, even though we do not have all the answers now. The key is that flexibility be maintained so that various approaches can be utilized depending on local conditions. Thus, the importance of establishing clearly defined objectives for the survey must be emphasized. Once this has been done, it will be much easier to develop appropriate mapping units and useful interpretations.

Subcommittee 5B - Woodland

J. A. DeMent	W. J. Lloyd
J. Ferwerda	R. Meurisse, Chairman
L. D. Giese	W. J. Sauerwein

Attachment 4

WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

Soil Interpretations
Committee 7

SYNOPSIS OF CHARGES TO THE COMMITTEE and
Committee Recommendations to the Conference

Charge 1. Prepare models of soil interpretations that can be made for order 3, 4 and 5 soil surveys.

The committee and the discussion groups agree that adequate models and examples of the use of these models of soil interpretation* are available.

There seems to be general concern about misunderstanding on the part of our customers as to the reliability of interpretations made for order 3, 4 and 5 *oil surveys.

1. The committee recommends that a more detailed "How the soil survey was made" section be prepared, more thoroughly describing field procedures. being more specific about sampling rates, and speaking specifically to the "statistical reliability' of soil maps and interpretation*.

2. The committee recommends that more specific guidelines be prepared on the fabrication of interpretive maps for multi-tan mapping units: or permit states wide latitude in the preparation of said maps, being subject to no review nor criticism et TSC or W.O. level.

Charge 2. Expand the concept of SOIL POTENTIAL

1. The committee recommends that soil suitability. soil capability end soil potential be defined to be mutually exclusive.

2. The committee recommends that the model for and example of a map unit description for order 3, 4, and 5 soil survey* be accepted. This recommendation speaks adequately to Charge 3. Committee 2, pertaining to map unit description*.

   The committee agrees to emend the statement in the pm-conference report pertaining to soil potential to read as follows:
   "SOIL POTENTIAL is related to the suitability of a soil for a specified use after the limitations that affect said use have been overcome.'

Charge 3. Prepare interpretation guides for organic soils using as an example the guides prepared in the northcentral and northeastern states.

The committee recommends that subject guides presented at end printed in the proceedings of the 1975 National Soil Survey Conference be field tested.

Charge 4. Evaluate procedure now used for obtaining crop yield potential.

The committee recommends that the conference request prompt delivery of guides to be prepared by a task force that was recently appointed to study procedure* used for obtaining crop yield potential.

The report of the committee was approved and accepted by the conference membership.

T. Holder, Chairman	D. Jones
F. Peterson	P. Singleton
G. Kennedy	J. Douglass
B. Seay	M. Openshaw
L. Langan	M. Miller
R. Huff	O. Harju
O. Bailey	J. Anderson

MATERIAL PRESENTED TO CONFERENCE DISCUSSION GROUPS
by Committee 7 - SOIL INTERPRETATIONS

Charge 1. Prepare models of soil interpretations that can be made for order 3, 4 and 5 soil surveys.

The committee begs to be confused at the charge. The question was interpreted by most to ask for methods of display of interpretive data.

The kinds of interpretations that can be made depends on:

1. The "umber and distribution of the points of reference; or the reliability of ground truth collected.

2. The scale of base map - limiting the size of area that can be show".

3. Kind (single or multiple features) of interpretive maps, and complexity of other display materials, e.g., tables, charts, narrative, etc.

To insure our agreement as to the level of detail. a portion of the table "Criteria For Identifying Kinds of Soil Surveys" from the 1975 NCSS conference was reproduced and presented to conference members.

At these levels of generalization can we do more or less than make general ratings as to SUITABILITY or POTENTIAL for uses as follows:

AGRICULTURAL
Cropland - nonirrigated and/or irrigated
Grazing Land - native (range) and pasture
Forest - wood products

NON-AGRICULTURAL
Housing - Subdivision Development and Single (Isolated) Dwellings
Industrial -
Trafficways
Recreation
Watershed

There are numerous possible models of ways to display the interpretations, probably the most comprehensive, and perhaps confusing is the SCS-Form 5 that can be used for any kind of soil mapping unit, and further used to ultimately generate a tabular presentation to enable the comparison of numerous map units.

The matter of how much descriptive information to present about the map units is subject to continuing debate. as is the matter of giving reasons for specific ratings for various uses.

The committee feels that adequate models are available - the problem. which will differ with each set of circumstances, is to choose one, modify it where necessary and proceed.

Development cf criteria for interpretations for the subject kinds of soil surveys seems to the committee to warrant no more than a restatement of the criteria currently used and currently being revised for making all kinds of soil survey interpretations. Briefly listed as follows these are:

SOIL FEATURES: Depth, texture, consistency. drainage, permeability, volume Of coarse fragments, slope, aspect, and toxic amounts of elements, or deficiencies of elements.

CLIMATIC FACTORS: Precipitation - amount and distribution, length of growing season, win.2 velocity, etc.

SOCIO-ECONOMIC FACTORS: Cost, relative desirability, nuisance factors, etc.

Charge 2. Expand concept of soil potential.

Some Observations on Soil Potential

Some confusion exists. or persists, concerning the difference between SOIL POTENTIAL and SOIL SUITABILITY. some individuals who do not hesitate to make ratings of soils that speak to suitability are hesitant to rate soils in terms of potential. Others feel that we should not rate in terms of either SUITABILITY or POTENTIAL, but should record the facts about soil characteristics and qualities as they are observed, and let the users (decision makers) draw their own conclusions.

A pertinent question to the conference at this point might be "Will we continue to rate soils for various uses?" Presuming an affirmative answer, will the conference accept the following:

SOIL POTENTIAL is related to the suitability of a soil for a specified use after the limitations that affect said use have been overcome. This will inevitably lead to the discussion of the "pro and con" of our becoming involved in "standards and specifications" or design. Further objections will be raised concerning our becoming involved in economic evaluations in which most of us profess, or confess, to having no expertise.

To the specific items in this charge the following are offered:

a. Develop a list of kinds of soil potential needed.

Ratings of the SOIL POTENTIAL can be and should be made for all land uses for which we presently make soil suitability ratings. i.e., Sanitary Facilities: Community Development; Water Management; Recreation Development; Crop end Pasture Production; Woodland Production. Wildlife Area Development; and Range Production.

b. Improvement needed to achieve potential.

Several examples of approaches to reaching the potential are:

Range Production Potential: 1) installation of fences and livestock watering facilities to get distribution of grazing animals; 2) establish rotational grazing systems to allow vegetation to recover from grazing; 3) reseed areas where desirable species listed as potential vegetation have been destroyed.

Crop Production Potential: The erosion hazard limiting the crop production potential can be overcome by 1) construction cf diversion terraces to reduce control damaging inflow of water; 2) construction of level. parallel terraces to reduce to steepness and length of slopes; and construction of grassed waterways to function as emergency spillways for terrace systems.

Community Development Potential: The area will have gwd potential for community development by installation of intercepting dikes and tile drainage systems to reduce wetness.

c. Model for Map Unit Descriptions

On the following pages are: 1) a model for Map Unit Descriptions for Order 3, 4 and 5 Soil Surveys; and 2) an example of such a map unit description.

Charge 3. Prepare interpretation guides for organic soils using as an example the guides prepare3 in the northcentral and northeastern states.

The committee recommends the adoption of the aforementioned guides, presented at and printed in the proceedings of the 1975 National Soil Survey Conference, as interim guides far field testing.

Charge 4. Evaluate procedure now used for obtaining crop yield potential.

Committee response ranged from none to the expression of satisfaction with the present system in some states. There seems to be little uniformity in the method of collection or expression of reliance on yield data.

Many gatherers of data experience great difficulty in the collection process. Many voice frustration with the method of display of yield data and the lack of timeliness of its display in published soil surveys. Collection of data over the life span of "project-type" soil surveys would in many cases present a "skewed" picture of the normal range of yields of many crops. Less frustration has been expressed concerning collection or display of yield data on native (range) vegetation and forest products than on crop yields.

MODEL

FOR MAP UNIT DESCRIPTIONS

FOR ORDER 3, 4, & 5 SOIL SURVEYS

Number and Name of Map Unit (from map)

Paragraph 1. General Statement
Location in state
Topographic statement
Slope classes and landform
Materials from which soils developed

Paragraph 2. Setting
Elevation - rounded to 500 feet
Percent Of slopes (range) rounded to 5 or 10 percent
Mea" annual precipitation rounded to 5 inches
Mean annual temperature rounded to 5° F.
Frost Free season rounded to 25 days
Total acreage in 10,000's and total square miles rounded to hundreds

Paragraph 3. Percentage of named map units and inclusions rounded to 5 percent

Paragraph 4. Description of each named nap unit
Soil depth - shallow, mod. deep, deep
Soil color - dark, light
Soil drainage - poorly. somewhat poorly. well
Soil texture (sandy, loamy, clayey)
Soil coarse fragments - kinds and amount
Slope (descriptive and percent)
Physiographic position (alluvial fans. hills, etc.1
Depth to bedrock - less than 20", 20 to 40", more the" 60"
Depth to seasonal high water table - range in feet
Flooding potential (if applicable - frequency and duration classes)
Shrink-swell potential
Frost action potential
Reaction of soil - range of classes

Paragraph 5. (Forestry. recreation, cropland, etc.)
Ownership - Federal, State. Private. Indian)
Native vegetation
(Trees - grass) Major species

Paragraph 6. Major limitations in use
(Cold. dry, rocks)
Potential of development

4 PSAMMENTIC EUTROBORALFS, loamy - ARIDIC HAPLOBOROLLS, loamy; gently sloping and sloping

This map unit comprises the Black Forest area of southern Douglas and Elbert counties and northern El Paso county. The soils in this association occupy the South Platte-Arkansas divide of the foothills and soils are formed in materials weathered residually or locally transported from arkose beds.

Elevations range from 6,500 to 7,500 feet. Slopes range from 0 to 25 percent but are commonly less than 15 percent. The mean annual precipitation is about 20 inches. The mean annual soil temperature is about 45° F. and the frost free season is about 100 to 125 days. This map unit covers about 190,000 acres. (300 square miles)

Psammentic Eutroboralfs make up about 35 percent of this map unit, and Aridic Haploborolls about 25 percent. Included in this map unit are other similar soils, and small area* of soils which are less than 20 inches to bedrock.

Psammentic Eutroboralfs: These deep, light colored, well drained soils have sandy surface layers and loamy subsoils and are on gently sloping to sloping areas of alluvial fans, and on sideslopes and crests of hills. Slopes range from 5 to 25 percent. Depth to bedrock is more than 60 inches and depth to seasonal high water table is more than 6 feet. They have rapid permeability. and a low shrink-swell and frost action potential. They are strongly acid to neutral in reaction.

Aridic Haploborolls: These deep. dark colored, well drained soils have sandy or loamy surface layers. loamy subsoils and are an gently to moderately sloping areas. They formed in arkosic sandy loam sediments on uplands. Slopes range from 0 to 10 percent. Depth to bedrock is more than 60 inches and seasonal high water table is greater than 6 feet. They have moderately rapid permeability and a low shrink-swell and frost action potential. They are typically neutral in reaction.

This map unit is used principally for range land, and home site development. There is some woodland harvest, recreation development and non-irrigated cropland. The native vegetation is predominantly Ponderosa pine with open areas of grasses composed mainly of bluestems, prairie sandreed, mountain muhle, blue grama, Junegrass and wheatgrasses.

The cold climate and limited rainfall are the major limitations to the use of these soils for cropland. The potential for development of homesites and recreation areas is good.

Factors limiting the potential of these areas for development of home sites are limited rainfall, moderately sloping to hilly topography and sandy surface layers that result in moderate to high erosion hazards and moderate constraints on placenent of septic tank absorption fields. These limitations can be overcome by: 1) construction of roads as nearly as possible on the contour, and reseeding disturbed areas; 21 restrict the size of graded areas to the minimum required; 3) select nearly level areas, or grade areas to nearly level foe placement of absorption fields; reseed or sod disturbed areas with drouth-tolerant species of grasses and shrubs.

NATIONAL COOPERATIVE SOIL SURVEY
WESTERN REGIONAL WORK PLANNING CONFERENCE
PHOENIX, ARIZONA, FEBRUARY 9-13, 1976

Attachment 5

COMMITTEE NO. 8 REPORT

SOIL SURVEYS FOR WOODLAND, RANGE, AND WILDLIFE

Committee Members:

F. Peterson (UNR, Nevada), Chmn.
G. Otte (SCS, Portland)
M. Fosberg (UI, Idaho)
B. Meurisse (FS, Ore)
G. Kennedy (SCS, Calif.)
B. Seay (SCS, N. Mex.)
T. Collins (FS, Alaska)
V. Hugie (SCS, Portland)
R. Parsons (SCS, Portland)
D. Richmond (SCS, Ariz.)
J. Allen (SCS, Ore.)
H. Havens (SCS, Ariz.)
A. Southard (USU, Utah)
J. Stroehlein (UA, Ariz.)
H. Waugh (BIA, N. Mex.)

Charges to Committee No. 8

(1) "Study relationship between interpretive groupings such as range sites and ecological sites, woodland sites and ecological sites and mapping units.

(2) "Identify the ..[requirements for] designing a mapping unit to be interpreted for range sites, woodland sites, ecological sites, etc. Develop a model that can be used for all."

(3) "Identify means of making useful interpretations of multitaxa soil mapping units."

(4) "Prepare ways of using ADP techniques to analyze soil surveys for use in resource planning."

Questions Discussed by the Committee

The committee was asked to reply to the following questions based on the charges to the committee. The term "habitat type" was used as a preferred term for "potential vegetation" or other vegetation identification.

Questions Relating to Charge No. 1:

(1) In your experience, do soil consociations identified at some proper taxonomic level always correctly predict the geographic location and kind of habitat type? That is, can we say that if a soil delineation is not wholly included within, or coincident with a habitat type delineation there is either an error in interpretation, an inclusion of contrasting soil, or that some environmental factor other than soil hasn't been recognized by phasing?

(2) Do soil associations and complexes give vegetative delineations which are useful?
(a) Is there some limiting small map scale, i.e., minimum size delineation and maximum size contrasting inclusion?
(b) Is there some limiting level of taxonomic generalization (including phasing) for the soil components?

(3) Can soil Series consistently predict habitat types? Do they usually have to be phased, or is phasing necessary only for utilitarian purposes such as site index?

(4) Can soil Families. or phases of Families consistently predict habitat types?

(5) Can soil Families, or phases of Families be used for utilitarian interpretations, e.g.. herbage yield, forest site index? Do you have examples?

(6) Can soil Subgroups, or phases of then be used to predict habitat types and utilitarian interpretations? Do you have examples?

(7) Could soil Subgroups, Great Groups, Suborders, or Orders be used to predict vegetative potential by classes in Categories more generalized than the habitat type?

(8) Do You have examples of vegetation classification hierarchies which might be used as alternatives to the habitat type-level for interpreting 3rd, 4th. or 5th Order soil surveys?

(9) Would it be useful to test higher-level Vegetation classes for interpreting 3rd. and 4th Order soil surveys? Who should do this testing, how?

Questions Relating to Charge No. 2:

(10) When you make vegetation interpretations do you work from soil properties (e.g., soil depth, water holding capacity, base saturation, etc.) through site requirements of plants to habitat type, yield, etc?

(11) Or. when you make vegetation interpretations do you use geographic coincidence of certain habitat types with polypedons or larger soil areas identified by (phases of) soil Series or higher taxa?

(12) Is it reasonable that some one kind of map unit design (e.g., consociations of phases of soil Series) should be, or could be advocated as a panacea for vegetation interpretations?

Questions Relating to Charge No. 3:

(13) In your experience, can soil complexes or associations be interpreted usefully for vegetation potential?
(a) Can the soil component identification be above the level of phases of soil Series?
(b) Are landform units (i.e., those defined primarily by other than proportions and pattern of constituent soils) interpretable?

(14) Should interpretive vegetation maps made from, and having some or all delineation boundaries coinciding with Soil complex or association delineation boundaries show only one dominant vegetation unit per delineation, or should they indicate proportions of component vegetation units?

Questions Relating to Charge No. 4:

(15) Would ADP input effort be profitable in the current situation where vegetation units are identified by ad hoc, uncorrelated names of only local and temporal significance?

(16) Is there a large enough, general enough body of knowledge on relations of soil properties to habitat types, single species occurrence, yield. etc.; to justify efforts at ADP analysis for soil property to vegetation interpretation results?

Committee Replies and Discussion

A number of committee members made extensive replies to the above leading questions posed by the chairman. They agreed on some points, diverged on others, and considered a few questions to be inconsequential. In summary, the committee correspondence suggested that there is a need for more effective interpretive techniques for Order 3, 4, and 5 soil surveys (or analogous generalized soil maps, or interpretively generated vegetation maps). More elaborate--perhaps more consistent--definition and description of multitaxa mapping units seems a precondition to better interpretations. Renewed informal and formal research on vegetation-soil relations is another apparent precondition. Some members considered rationalization of vegetation nomenclature, hierarchical classification, and mapping concepts a desirable goal to be encouraged. Several members stressed that utilitarian interpretations (e.g.. productivity, management technique, reseeding, etc.) are much more important to users than maps of potential vegetation. The problems of comparability of various resource inventory of interpretive maps was introduced, but not pursued.

Recommendations from the Conference

A working draft report, summaries of committee correspondence replies to leading questions and a set of tentative recommendations were presented to the entire conference. They encouraged vigorous discussion on several points. The conference members showed particular interest in soil moisture regime - natural vegetation relations. The conference approved the following recommendations from Committee 8:

(1) Vegetation units, or landscape areas with an ecological potential to support a particular vegetation (e.g., habitat type) should be named after their identifying plant communities, in addition to common names, and should be at least regionally correlated before they are used for soil-vegetation interpretations.

(2) The basis for making soil-vegetation interpretations (e.g., habitat types for various soils) should be identified in soil survey reports, as should the basis for any other soil interpretation. (Soil properties and geographic correlation are two broad categories for soil-vegetation interpretation criteria.)

(3) Vegetation specialists should be encouraged to provide one or several heirarchical vegetation-landscape classifications for use with order 3. 4, and 5 soil surveys.

(4) The SCS Soil Survey Investigations unit should be encouraged to give priority to field studies of soil moisture and temperature regimes and related vegetation patterns and management responses.

(5) Regional efforts at routine ADP analysis of soils-vegetation interpretations are not warranted at the present time. Analyses of selected data for research purposes should be encouraged.

(6) Vegetation specialists should be encouraged to describe the techniques and concepts by which they map vegetation and define mapping units. so that definitive analyses of soil map-vegetation mapcomparability can be made.

SUBCOMMITTEE 5C - WILDLAND

No report received, but subcommittee chairman will submit the report of the findings of the task force on Soil-Wildlife Interpretations for the Western States.

Committee Members

L. Dean Marriage, Chairman	G. E. Otte
L. L. Buller	C. M. Thompson
R. C. Carter	

AREA TASK FORCE ON SOIL-WILDLIFE INTERPRETATION

The Program Report of the Task Force has under review:

1. A Wyoming State Office draft of key wildlife plants for selected wildlife species in an effort to develop a more complete list of key habitat elements and rating tables than is now contained in SCS Soils Memorandum-74 and related SCS Soils Form-5.

2. Suggestions for improving the key habitat element rating tables by incorporating soil moisture regime and soil temperature into the criteria.

3. Definitions of "good," "fair," "poor," and "very poor" in SCS Soils Memorandum-74 for rating habitat elements.

Responses from the Task Force members on Wyoming's proposal have been received and are being analyzed and summarized by the co-chairmen. There is substance and practicality in the concept of a better and more complete grouping of key habitat elements and habitat kinds. These will be used to modify the wildlife section of SCS Soils Form-5 to accommodate additional key habitat elements and habitat kinds. Increasing the choice of key habitat elements and habitat kinds will give the rater greater flexibility in the rating process. The definitions of "good," "fair," "poor," and "very poor" remain unchanged at this writing.

There is general support for interpreting soil mapping units, composed of two or more elements, for wildlife habitat components. This is in addition to interpreting soil taxonomic units.

L. Langan/L. D. Marriage, Co-chairmen
1/21/77

CONDENSED REPORT OF COMMITTEE 6 ON "INTERACTIONS BETWEEN SOILS AND FERTILIZER RESPONSES" FOR THE 1977 WORK PLANNING CONFERENCE OF THE NATIONAL COOPERATIVE SOIL SURVEY IN ORLANDO, FLORIDA, JANUARY 30-FEBRUARY 4

Requests for responses to the charges to Committee 6 were mailed to all the states and to several other countries. Mailings were directed first to the Head of the Agronomy Department in each Land Grant College, then (for states not responding) to the Director of the Soil Survey Operations for the Land Grant College, then (for states still not responding) to the State Soil Scientist, and finally to selected individuals. All of the states were contacted and all of them ultimately responded. Many of the workers responded in detail and with an enthusiasm and effort beyond our greatest expectations. Selected examples of some of the responses from Kansas, Mississippi, Missouri, Montana, Ohio, Puerto Rico, SCS-Lincoln, and South Dakota were included in pages of correspondence attached to the preliminary reports. The workers in each state can best express their local situation, opportunities, and challenges; the chairmen, advisors, and members of Committee 6 are extremely appreciative for the responses of all of the workers.

All of the responses have been published as Cornell Agronomy Mimeo 77-2 of about two hundred pages, so that this excellent national perspective of work on interactions between soils and fertilizer responses can be available at cost of reproduction to all who are interested in it. The subject setter of the charges is massive, but of extreme national importance if the uses of soils are to be improved. In general, fertilizer trials in the past have been conducted without much regard for the soils (as described in the soil survey); increasingly, however, geographic variabilities of soils are being investigated both between and within delineated soil map units. The reason that soil map unit variability and yield correlations have not been much studied in the past is simply that detailed soil maps were not previously published for large areas of the country; the new accelerated soil report publishing program will surely stimulate many investigations of soil map unit variabilities in the future.

Most quick test labs in the USA make sane use of soil series names, but few use soil map units to their full potential in making fertilizer recommendations. In a number of cases chemical tests alone have actually been misrepresentative of the present or potential productivity of the soils; Cornell Bulletin 513 in Mimeo 77-2 excellently illustrates this fact. Recent trends toward computerization of soil test results' and recommendations are certain to improve the relating of data to soils---especially as soils of more areas are mapped and the reports are published. Generally, the progress in correlating data to soil map units will be limited by the rate of soil map publication and by the funding of data-gathering and of computer and statistical studies. Acceleration of soil survey interpretation activities would be a good investment to make soil surveys more useful in the future.

CHARGES TO COMMITTEE 6
ON INTERACTIONS BETWEEN SOILS AND FERTILIZER RESPONSES

1. Collect and evaluate data on the responses of crops to fertilizers by named kinds of soils. Consider interactions between such responses, management practices and weather conditions, and explore techniques for defining optimal practices by kinds of soils.

2. Review the use of soil survey information by soil testing laboratories. Study whether and how the interpretation of soil test results could be improved if soil survey information were used more effectively.

3. Explore possibilities for considering critical constituents (high Al, low Ca, trace elements) in soil classification and for incorporating information on fertilizer responses (including trace elements) in soil survey interpretations.

Chairman: Gerald W. Olson
Vice-Chairman: Harold Owens

Members :

F. Allgood
S.W. Buol
F. H. Beinroth
D. G. Grice
R. L. Guthrie
T. J. Holder
T. B. Hutchings
L. N. Langan
J. H. Lee
J. O. Nichols
G. J. Post
D. W. Swanson
R. I. Turner
R. D. Yeck

Advisor: K. W. Flach

RECOMMENDATIONS FOR IMPROVING
INTERACTIONS BETWEEN SOILS AND FERTILIZER RESPONSES
as formulated by Committee 6 of the 1977 Work Planning Conference

1. Analyze available relevant data and gather new data specifically to correlate crop yields to detailed soil map units. Workers at experiment stations should lay out plots or experimental crop strips in a sequential pattern across contrasting soils to supplement the traditional more obsolete plot layout which assumes perfectly uniform soil conditions.

2. Improve recordings of soil map units at locations where soil fertility samples are collected and enter soil names into computer format for statistical correlations.

3. Initiate research into soil map unit variability to enable better probability statements to be made about predicted yields of landscape areas.

4. Evaluate soil properties to determine soil potential under different management systems designed for at least several alternative economic and cropping situations in each local area.

5. Submit pedological soil horizon samples also to soil fertility laboratories for characterization of horizon soil fertility as well as soil genesis.

6. Start systematic modern large scale soil surveying and sampling of experiment stations, beginning with those of the greatest importance to the most productive agricultural areas.

7. Organize a symposium between soil fertility workers and pedologists for upcoming meetings of the American Society of Agronomy--R. B. Grossman will handle this.

8. Achieve cmrdinations of the soil survey with the soil testing laboratories--H. I. Owens will investigate these procedures.

9. Set up regional projects to relate soil fertility data to detailed soil map units--E. Miller will identify these procedures and ancourage proposals that will be funded.

10. Establish priorities to achieve the funding to carry out the recommendations to met the needs--on local, state, regional, and national levels.

NEEDS FOR IMPROVING
INTERACTIONS BETWEEN SOILS AND FERTILIZER RESPONSES
as formulated by Committee 6 of the 1977 Work Planning Conference

1. Need correlations of crop yields to soil map units--for improving soil survey interpretations for crop production.

2. Need correlations of soil tests to soil map units--for improving soil management recommendations.

3. Need studies of soil map unit variability--to define crop response variations of soil map landscape units.

4. Need evaluations of soil potential--to specify alternative cropping systems and feasibility of those systems.

5. Need quick test data on all soil horizons--to characterize the fertility status of subsoils and substrata as well as topsoils.

6. Need first order (large scale, high intensity) soil maps, deep soil profile samplings, and analyses of soils in map units in experimental stations--to enable correlations of crop data to mapped soils outside of the stations.

7. Need additional dialogue between soil fertility workers and pedologists--to start and expand cooperative efforts.

8. Need ccordinations of the soil survey with national soil testing associations--to bring about cooperations and ccordinations between soil test laboratories and soil mappers.

9. Need regional research projects on correlations between soil fertility work and soil survey efforts--to improve uses of soils for agriculture in the VS..

10. Need funds for the above listed efforts to meet the needs.

STATUS OF RELATIONSHIPS BETWEEN SOIL FERTILITY AND PEDOLOGY

The future of soil science in the United States depends to a large extent upon the relationships between the subdisciplines of soil fertility and soil survey (pedology). Responses on the status of these relationships have been received from all the fifty states and some other areas as part of the work of Committee 6 for the 1977 Work Planning Conference of the Cooperative Soil Survey. Specifically, the charges to the committee and to the states were to:

1. Collect and evaluate data on the responses of crops to fertilizers by named kinds of soils. Consider interactions between such responses, management practices and weather conditions, and explore techniques for defining optimal practices by kinds of soils.

2. Review the use of soil survey information by soil testing laboratories. Study whether and how the interpretation of soil test results could be improved if soil survey information were used more effectively.

3. Explore possibilities for considering critical constituents (high Al, low Ca, trace elements) in soil classification and for incorporating information on fertilizer responses (including trace elements) in soil survey interpretations.

The responses from the states constitute an amazing collection of reports, indicating excellently the problems and potentials for improving these relationships. If one reads between the lines in the reports, one can see in the different states the devastations caused to research programs by budget cuts, the deficiencies in lack of initial appropriations, and, (in contrast) the constructive accumulations of valuable data through sustained fundings. Research and extension philosophies are clearly pointed out. Complications of nutrient variability of soil map units are outlined. Selected references are listed. Along with the reports from all of the states are included needs and recommendations of Committee 6 for future actions to mutually benefit both soil fertility and pedology. Copies of these materials have been reproduced as Cornell Agronomy Mimeo 77-2 (about 200 pages), and are available from the chairman of Committee 6 at cost of reproduction. The Mimeo 77-2 should be of considerable value to administrators of national and state research programs and to research and extension workers planning programs in both soil fertility and pedology. The reference is: <u>Soil Survey Staff Committee. 1977. Status of Evaluations of Interactions Between Soils and Fertilizer Responses in the States of the United States and Some Other Areas: Report on Responses to the Charges to Committee 6 (Interactions Between Soils and Fertilizer Responses) for the Work Planning Conference of the National Cooperative Soil Survey in Orlando, Florida, 30 January-4 February 1977. Cornell Agronomy Mimeo 77-2, Department of Agronomy (Soils), Cornell University, Ithaca, New York 14853</u>---Gerald W. Olson (Chairman of Committee 6), 707 Bradfield Hall, Cornell University.

NATIONAL SOIL SURVEY CONFERENCE

Orlando, Florida
January 30 - February 4, 1977

Committee No. 7 - Organic soils

Charge: Review comments and make recommendations on the proposals on the classification and interpretation of organic soils and associated mineral wetland soils developed by the Organic Soils Committee of the 1975 National Soil Survey Conference.

Summary of Previous Work

Renewed efforts toward interpretations of organic soils began with the formation of the National Task Force on Organic Soils in June 1972. The Task Force met and prepared a report that was considered by the Organic Soil Committee at the National Work Planning Conference (1973). After further owrk and testing the interpretations were again considered by the committee in 1975 and presented in the report of that conference. As a result a number of guides have been developed (Table 1) with recommendations for regional testing. Land uses and methods of interpretation are as follows:

For Cropland

A. Management Suitability (General)

A system of rating both organic and mineral soils has been developed, based upon penalty points for unfavorable soil features, to rate soils for "management suitability for cropland". Management suitability is defined as an interpretive classification to assess the limitations for management of individual soils and the production of crops in general. The system illustrated applies to the North Central and Northeast states. A wide array of values is possible (0 to more than 120), however, placement in 8 groups is illustrated. Separate guides are suggested for land resource areas or other geographic areas.

The end result of the ratings, as illustrated, resembles somewhat a grouping by land capabilities, at least in the number of classes. They are however more precisely defined and more nearly reflect production potential if used for cropland. Since management suitability is based on different assumptions, the classes that result cannot be equated to land capability classes.

Although penalty points are assigned to unfavorable soil properties an explanation of the effect of the property upon performance is not included.

Table 1. Summary of Guides for Interpretation of Organic Soils

LAND USE	Applicable to		Proposed Classes		Data Needed	
	Organic	Mineral	No. (discrete)	Array by sum of penalty points	Series	Onsite Investigations
Cropland						
General	yes	yes	8	yes	yes	no
Specific	yes	yes		yes	yes	no
Development difficulty	yes	no	3	yes	--	yes
Woodland						
General	yes	no	5	yes	yes	no
Specific	yes	no	none	no	--	yes
Structures (for planning purposes)						
Floating light loads	yes	no	none	yes	?	yes
Excavations and removal	yes	no	none	yes	?	yes

B. Management Suitability (Specific Crops)

Management suitability for specified crops is presented for the North Central and Northeast states and is based upon the same soil features as general management suitability for cropland; however, the features may be given different weight for each crop. The penalties resulting from unfavorable soil features are summed with a possible range of 0 to more than 120. The intention of the committee is not clear as to whether the suitabilities are presented by groups or numerical indices. Yield potential is not a part of the rating.

C. Development Difficulty for Areas of Organic Soils (For Cropland)

Development difficulty is a rating for use in conjunction with management suitability. It is a method of establishing a rank that indicates relative ease (cost ?) of land clearing and drainage. As a result, soils having equal management suitability but bastly different development costs can be distinguished. Vegetative cover, surface roughness, and establishment of adequate water control are three of the criteria, none of which are used in soil classification; although, they may be characteristics of mapping units. Kinds of underlying materials and coarse fragments within 51 inches are the other criteria, and these are used in soil classification. The sum of possible indices ranges from 0 to more than 100 with placement in three groups proposed.

Forestry

Use potential groups are developed on the basis of 7 soil features significant to tree growth, to which penalty factors are assigned. On the basis of the penalty factors a 5-class ranking, from best to poorest, of each soil feature has been devised as a basis for use potential groups. The soil is rated by the class in which its most limiting feature is placed in a similar manner to use of guides for engineering interpretations. The effects of adverse features are not additive. None of the properties used as rating criteria are unique to organic soils.

As an illustration of use, soil series are placed in use potential groups and site index given for selected tree species. Ranges of site index for soil series within Use Potential Group 3 for the seven species are as follows: 20-35 (black spruce), 40-55 (tamarack), 30-40 (n. white cedar), 45-55 (balsam fir), 55 (black ash), 60-80 (red maple) and 90 (silver maple).

The committee makes the following significant statements in regard to penalty factors and Use Potential Groups:

1. Penalty factors give a basis for a general rating for forestry and a basis for analyzing soil potential for individual species. Some indicator soil properties are more critical for one species than another.

2. Use Potential Groups are for general evaluation of organic soils for forestry uses over broad areas.

3. Interpretations for organic soils need to tie in with those of mineral soils since both types of soils are likely to occur on the same property. A rating system that will reflect the needed interpretations for both types of soil is desirable.

4. Where soil surveys are available the interpretations should be geared to the mapping units or soil series (although not stated as such, the implication is that site index by species is intended).

   Where soil surveys are not available the key indicator properties need to be rated to help analyze the production potential of key species. (This implies use by nonsoil scientists on the basis of onsite examinations or evaluation by soil scientists where site data for the soil encountered is not available.)

Interpretive Guides for Planning Purposes

Early work of the committee and the National Task Force dealt with rating criteria for dwellings with basements. Subsequent efforts were aimed at less costly developments and more general ratings for planning purposes.

A. Floating Light Loads on Organic Soils

   This guide is intended to rate organic soils with respect to their suitability for farm access roads, small buildings other than dwellings, and cattle walkways where completely firm and solid foundations are not warranted. The system is based upon penalty points for 7 unfavorable soil features. The effect of soil preperties on the use are explained.

B. Excavation and Removal of Organic Materials (Including displacement of soft materials below a depth of 12 to 15 feet)

   This rating is an effort to show the magnitude of problems associated with removal of organic soil material and/or displacement by surcharge. Criteria are based upon soil properties much deeper than the normal depth of observation or classification. Two soil factors are rated as affecting excavation and three properties for displacement. Penalty points are assigned to the adverse factors. Background material prepared by the committee on use of this rating is inadequate.

Discussion of Previous Work

As a result of the committee's effort, rating guides have been prepared for selected uses. Many soil properties have been considered and their significance to interpretations evaluated. Discussion or explanation of the effect of the property on the use is only given for interpretive guides for planning purposes. Useful guides have been developed for a systematic analysis of soil properties as a basis for interpretations. A two-year test of the guides by regional committees is underway and will not be fully evaluated until the regional committees meet in 1978. Nevertheless, regional committees did respond to varying degrees to proposals set forth as the 1975 National Soil Survey Conference.

There are differences among the guides as to levels of generalization of land use, applicability to both organic and mineral soils, number and kinds of classes and whether ratings may be made for series or require onsite investigations. Some of these differences are listed as follows:

1. The cropland rating system provides for a general guide to suitability for cropland as well as crop specific ratings (as for soybeans).

2. The cropland system applies to both organic and mineral soils but others are limited to organic soils.

3. Both discrete classes and numerical array are suggested for woodland and cropland but only numerical array for structures.

4. Onsite investigations are required for 4 of the 7 ratings proposed.

5. None of the guides suggest treatments to overcome the limiting factors.

The features unique only to organic soils, other than folists, or of special concerns in interpretations of organic soils have been abstracted from the rating guides or divisions and are listed as follows:

- Kind of soil materials
  - Fibric
  - Hemic
  - Sapric
  - Limnic
    - Coprogenous earth
    - Diatomaceous earth
    - Marl
- Origin of soil materials
  - Woody (needs definition)
  - Herbaceous
  - Sphagnum
- Thickness of organic soil materials
- Resistance to rewetting after dehydration of limnic soil material
- Lateral hydraulic conductivity
- Susceptability of crops to frost
- Mineral stratification
- Wood fragments (coarse)
- Kind of underlying soil material (w/in 51 inches)
- Soil Temperature
- Growing degree days
- Aluminum
- Trace elements (Cu, Mo, B, Ca:Mg balance)
- Sulphidic soil material
- Sulphurous horizons
- Subsidence
  - initial
  - annual
- Surface densification
- Bearing strength
- Erodibility

Committee Action

The committee chairman summarized the work to date and asked that committee members respond not only to the regional committees reports but to queries designed to identify the needs to be met by the rating systems, the potential users, and methods of application. Seven of the 17 members responded. There were few exceptions to reports prepared by the regional committees. The following is a summary of response to the queries :

1. The Land Capability Classification, Woodland Ordination Groups, Range Sites, yield estimates, site index and soil limitation ratings for various uses provide some interpretations for organic soils. When implemented, the ratings for soil potential will provide an additional interpretation. Prior work of the committee more nearly equates to the soil potential concept than to the other systems.

   Needs for rating systems and purposes to be served by ratings were identified by the committee as (a) identification of properties of organic soils that are important to classification or phase distinction; (b) inventories of "suitability" at local, regional, state or national levels; (c) land use planning and selection of alternatives; (d) identification of management needs; and (e) a guide for on site investigations including site conditions and properties below the series control section which may or may not be characteristic of soil mapping units.

   The committee strongly favored reference guides for on site examination with latitude for local deviations from the standards. In addition to the foregoing, the committee felt that ratings systems should apply to general land uses such as cropland, woodland, etc. as well as specific uses such as for potatoes, red maple, etc.

   Guides to meet the needs and uses identified by the committee represent and undertaking of considerable magnitude and duplicate the results of those working on the ratings of soil potential.

2. The committee is equally divided as to whether ratings developed should apply only to organic soils to facilitate comparison of one organic soil to another or whether ratings should apply to both mineral and organic soils to facilitate comparison of all soils on a given tract of land or other geographic area. Guides for cropland submitted by the national committee in 1975 applied to both mineral and organic soil, however guides for woodland and structures were only applicable to organic soils. Any guide must consider properties of mineral soil layers because these are an important feature of many organic soils.

For uses or crops unique only to organic soils, rating systems need only apply to organic soils. When a choice must be made between use of a mineral soil and use of an organic soil for the same purpose it is fairly obvious that interpretations prepared from the same scale of values will be much easier to use.

It would be helpful to the committee if this conflict in views was resolved.

3. Adequate testing and evaluation of the guides is essential before they are recommended for use. Committee members responding to this issue felt that guides need to be tested by users. This is interpreted to mean woodland managers, farmers, extension workers, and soil conservationists in addition to soil scientists who prepare the guides.

4. Some important uses of organic soils for which the relationship between properties and performance need to be established are as follows:

Cropland
- shallow rooted (vegetable, etc)
- deep rooted (corn, etc)
- fruit crops

Pastureland
Rangeland
Sod production
Small structures (floating)
Foundations (stable)
Waste disposal
Commercial use
- peat moss (sphagnum)
- peat humus

Fuel
Drainage

Recommendations

1. That the list of features unique <u>only</u> to organic soils or of special concern in interpretations of organic soils be reviewed and amended as needed.

2. That material be prepared in appropriate format whereby the unique properties of organic soils that are significant to each major use are listed and the effects briefly discussed. This would summarize Present knowledge, be a useful guide for interim use, identify research needs, and provide needed background for evaluation by way of the soil potential concept.

3. That the committee expand its efforts to include work on horizon designations and conventions for description of organic soil horizons.

4. That regional committees compile estimates of acreages of organic soils by soil families.

5. That regional committees continue testing of the interpretive guides, evaluate their usefulness and report to the national committees at the conclusion of the two year testing period.

6. That the committee be continued.

D. L. Bannister	H. R. Finnery	W. C. Lynn
J. E. Brown	R. F. Fonner	J. E. McClelland (Advisor)
H. J. Byrd	K. C. Hinkley	E. W. Neumann
L. P. Dunnigan	R. W. Kover	J. J. Rasmussen
K. R. Everett	R. E. Lucas	0. W. Rice
R. S. Farnham (V-Ch)	S. Rieger	D. F. Slusher (Chairman)

Discussion

Daniels - Mapping the underlying mineral material is extremely difficult in raised bogs.

Slusher - Difficulty in mapping is not sufficient reason for excluding underlying material, especially that within 51 inches, from consideration in interpretations.

Farnham - We need to know what the mineral soil will be like if the organic soil material is removed for fuel or is oxidized through farming operations.

Grossman - What are the arguments for rating systems that apply to organic soils but not mineral?

Slusher - Some view organic soils as unique and a standard for comparing one with another is useful. Others are of the opinion that users of the soil survey will want to compare all soils on a given tract of land--both mined and organic. The need to be met could not be agreed upon by this committee.

SOIL SURVEYS FOR CHANCING NEEDS

It is a pleasure to participate in the work-planning conference of the National Cooperative Soil Survey, and to see representatives from so many agricultural experiment stations, other agencies, and even other countries. This kind of interest should result in better soil surveys. and wider use of them.

In the United States, the demand for soil survey information keeps growing. Funds for soil survey activities keep growing--but not fast enough. The Soil Conservation Service has about 1,140 soil scientists directly engaged in making soil surveys.

This number has remained constant over the past several years while the overall number of soil scientist employed by our cooperators has increased from 190 in 1969 to 475 in 1977. In 1977, about 58 million acres of soil surveys are planned, compared with 50 million acres surveyed in 1969.

We intend to maintain our efforts to reduce the time required to publish soil surveys. We never could afford to let 4 to 8 years elapse after field work is completed! We plan to cut the average time span required for publication to 40 months in FY 1978, to 31 months the following year. h'e can't stop there. We now know that it is possible to publish within 12 months after mapping is completed; we did so for the soil survey of Washington, D. C. All surveys will be published within a year after mapping as our current backlog is reduced.

Comprehensive information about the properties and condition of soil resources is needed quickly as America faces many vital issues. For example:

1. - Energy needs in agriculture are related to soils. We need to study closely the tillage practices required to minimize energy use and still obtain good stands and yields. These practices vary by kinds of soil.

2. - Proper reclamation of surface mined land requires soil survey data. We insist that soil reconstruction is necessary so that the productive capacity of the soils after mining is not diminished.

3. - To minimize the use of and hazards from fertilizers, pesticides, and other chemicals in farming, we must tailor their use to soil properties.

4. - Delineation and management of wetlands require soil survey data.

Speech by R. M. Davis, Administrator, USDA Soil Conservation Service, At the work-planning conference of the National Coopertive Soil Survey, Orlando, Florida, February 4, 1977.

5. - Specifications for safe disposal or re-use of waste products depend on soil characteristics.

6. - Proper use of irrigation waters to minimize salinity in soil and water must be based on soils information.

7. - Extensive efforts are being directed to meeting the water quality standards of PL 92-500. Soil surveys will be required. We also are making an erosion survey of the soils that are the major sources of nonpoint pollution.

a. - Land use is another national concern. Every year, about 3 million acres of privately owned land in the United States are converted to urban uses or covered with water. This includes 670,000 acres of cropland. We cannot afford to let this erosion of our soil resource continue indefinitely. State and local planning agencies need to know where important croplands are to slow their conversion to other uses. We are using soil surveys to identify these lands as part of our important farmlands inventory.

To meet all these needs, the National Cooperative Soil Survey must intensify its efforts to collect the necessary information...to relate it to recognized kinds of soils... to convert it into a form that can be used by people who are not soil scientists... and to make it readily accessible in a resource information system.

To collect this information we have to improve research capabilities supporting the soil survey and work closely with research agencies.

I am pleased with the strong representation of federal research agencies at this conference, particularly the Agricultural Research Service and the U.S. Geological Survey. Our challenge is to relate their findings to identified kinds of soil and, in turn, help research agencies plan their work to provide valid information for the whole spectrum of soils that we recognize. Research can be planned to fill in gaps in our knowledge. Our challenge is to coordinate our activities so that each individual can make the most effective contribution. SCS has strengthened its soil investigations program through the creation of a national soil survey laboratory and through soil survey investigations specialists at the technical service centers. As Dr. Eno stressed at the beginning of this conference, we have to take full advantage of the unique contributions that our cooperators at the land-grant colleges make to this effort. They contribute through their own research and through their close working relations with disciplines in the earth and other environmental sciences.

We also need to strengthen our efforts to convert technical information into a format that can be used by people who are not soil scientists. In the past we have stressed interpretations related to the limitations of soils for specific uses. We are now taking a more positive approach to interpretations by developing potential ratings for specific soils.

Soil potential ratings and other interpretations require inputs from many disciplines. These ratings are intended 8s planning tools--not design criteria or specifications or final site selection. They should reflect the comparative quality of soils--in terms that do not require translation.

The ratings recognize soil quality in terms of performance possible after limitations are overcome through economically feasible practices. Thus, the ratings may be simple but the logic behind them may be complex. The soil potential activity will be expanded greatly--and will require major contributions from other disciplines.

The right information, in the right format, still has to get to the person who needs it. SCS is working on a comprehensive system for collecting, updating, and evaluating data in an information system. It will include an advanced mapping system that will help us in preparing maps and in developing advanced methods for their use. Ultimately, we hope to include all of our published soil surveys. From this data bank the location and extent of each mapping unit can be determined. Interpretive maps of many kinds can be prepared from stored interpretations.

As we complete and publish soil surveys at a faster rate, workloads at all levels in SCS are growing. We have been shifting responsibility from our national office to field and state staffs for completing soil surveys, especially for classifying and correlating soils.

This would not have been possible without 8 comprehensive system of soil classification. Since this conference met two years ago, Soil Taxonomy has been published. I want to acknowledge the extensive help and close cooperation of soil scientists in the United States and many other parts of the world in bringing the work to this stage. It is not the "final word." It already use some changes. As new knowledge is obtained about soil classification we will make changes.

Our mutual aim must be to relate soil facts to land uses and management techniques in ways that people can understand and use these facts. The people who use our information are as varied 8s the soils they manage. Soil surveys must be flexible enough to fit their needs.

Many users also require professional help to get full value from soil surveys. Land use and the environment will not improve simply by placing soil surveys in the proper federal repository. I challenge all of you to contribute the same enthusiasm and innovation to survey distribution, use, and technical assistance 8s you continue to give to data gathering and interpretation and to furthering soil science.

We believe that the new administration will strongly support our efforts related to land use and the environment. Jimmy Carter said in 1975, “This is no time for those of us who love God’s earth and the beauty of it, the purity of the air and water, to compromise or to retreat or to yield in any possible measure to the devastation or deterioration of the quality of our lives or our **environment.”**

Soil science is making its own profound contribution **to** “visible conservation” in America and throughout the world--let us step up the pace.

Recommendations of the committee to provide guidelines for the 1979 Work Planning Conference of the NCSS, John E. McClelland, Chairman, Kermit Larson, John D. Rourke, Maurice Stout, Jr., and Eugene P. Whiteside.

The committee received many suggestions from conference participants and these were appreciated. 'In general the suggestions were to narrow the charges given to committees so that specific assignments can be completed wherever possible. In addition some response should be provided to regional committees where comparable national committees are not established.

The committee has the following recommendations:

1. A steering committee for the 1979 conference should be named as soon as possible after the 1977 conference. It will consist of 11 members as follows:

    a. Chairman, Assistant Administrator for Soil Survey, SCS;

    b. A representative from the Washington Office Staff of the SCS, to handle administrative details and to be contact member for other federal agencies except the Forest Service,

    c. The Forest Service soil leader;

    d. A member selected by the agricultural experiment station soil survey leaders for each region;

    e. The four principal soil correlators.

2. By May 1, the steering committee will provide subjects and a list of changes for the 1979 National Work Planning Conference Committees and recommend committee chairmen. They will gain approval for the participation of the committee chairmen from appropriate authorities.

3. By July 1, 1977, committee chairmen will review the charges and submit to the steering committee:

    a. Proposals, if any, for further refinement or clarification of the charges;

    b. A list of suggested committee members.

4. By September 1, 1977, committee members and approval for participation should be completed.

5. As soon as regional work planning conference proceedings are available the chairman of the steering committee will ensure that chairmen of each national committee receive copies of the regional reports.

6. By November 1, 1978, each national committee chairman will submit 90 copies of a draft of his report to the chairman of the steering committee.

7. Prior to December 1, 1978, the chairman of the steering committee will provide conference participants with copies of the drafts.

a. The 1979 National Work Planning Conference is tentatively scheduled for the week of January 24, 1979. The place will be determined by the national steering committee by May 1, 1977.

9. The chairman of the national steering committee will ensure that all recommendations of regional committees are provided some response at the national meetings.

The committee believes the format of the 1977 meetings should be followed although the reports given the first day could be scheduled for 2 morning sessions providing meeting rooms can be scheduled to accommodate this change.

NATIONAL SOIL SURVEY CONFERENCE

ORLANDO, FLORIDA, Jan. 31 - Febr. 4, 1977

REPORT OF THE COMMITTEE ON THE CLASSIFICATION OF ALFISOLS AND ULTISOLS WITH LOW ACTIVITY CLAYS

By F.R. Moormann*, Chairman

1. -Introduction

The committee was established in March 1975, by the SCS; participating in the committee's work are 25 members and correspondents from 11 countries who are or have been actively engaged in soil survey and classification in the inter-tropical region. The work of the committee is mainly conducted by correspondence; information and discussions are communicated by way of circular letters from the chairman. No official plenary committee meetings are held, but members of the committee meet on occasion of various international events. Apart from the Orlando meeting, two more work sessions are being arranged for 1977, i.e. during an EMBRAPA - U of Puerto Rico workshop in Brazil in June-July, and during the ISSS meetings in Malaysia, in August.

2. Mandate and justification

The committee is charged to recommend changes in SOIL TAXONOMY, leading to the upgrading of Alfisols and Ultisols, in which the argillic horizon is dominated by low activity clays, mainly kaolinitic. These are the present "oxic" subgroups, but will include a considerable additional number of low activity clay taxa in Alfisols and Ultisols, in which oxic subgroups have as yet not been recognized in SOIL TAXONOMY.

* International Institute of Tropical Agriculture, PMB 532.0, Ibadan, NIGERIA.

The "upgrading" of oxic subgroups can be justified on various grounds: geographically they are very widespread; the present level is too low to permit meaningful further subdivision at the higher categorical levels and, in terms of properties related to soil management and crop production, they stand well apart from soils, dominated by high activity clays.

3. Categorical level. nomenclature and diagnostic characteristics

The categorical level, recommended to accommodate the "low activity clay soils" is that of the great group. A higher level is technically unadvisable, and would probably entail too many and too far reaching structural changes in Taxonomy. For the great groups, to be created, the prefix "kandi" was chosen out of many; kandi being derived from the general term for kaolinitic clays, i.e. kandites.

The tentative diagnostic criteria for the "kandi" great groups would be the following:

i. - A CEC of less than 24 meg per 100 g clay (NH_4OAC) in the upper 50 cm of the argillic horizon.

ii. - less than 10 percent weatherable minerals in the 20-200 micron fraction of the upper 50 cm of the argillic horizon unless present in saprolitic material.

iii. - no fragipan or "continuous-phase" plinthite.

Under debate is a value sub(i) for cation retention by NH_4Cl. which some feel should be replaced by a diagnostic value of ECEC per 100 g clay (sum of cations plus 1N KC1 extractable Al at the soil pH).

It is recommended that "kandi" great groups be keyed out early, i.e. immediately after fragi-and plinth-great groups, if present.

While most of the "kandi" taxa have their widest distribution in the intertropical zone, they do occur in non-iso soil temperature regimes as in the US and Europe. This is a consequence of the committee's decision not to recommend a soil temperature regime limitation parallel to the "Trop" suborder and great groups.

Various points are still under discussion, one of the main ones being the admittance of a thin oxic horizon (more than 30 cm, less than a value still to be determined), overlaying the argillic horizon.

A draft-key for Kandiudults was established, which is now being tested.

It is intended to submit more complete recommendations to SCS, early in 1978.

4. <u>Repercussions for SOIL TAXONOMY, as applied to the US and Puerto Rico</u>

Upon presentation in ORLANDO, various points of the interim - reporting of the work of the committee came under discussion. Of importance are following points:

- The diagnostic values for CEC, base saturation, etc. require further scrutiny, especially in view of analytical methods. In low activity clays, small errors in such data may have a relatively large effect, e.g. as regards pH dependency of CEC values.

  The classification of soils with plinthite may require a complete new approach.
- The classification of soils from basic and ultra basic rocks, with a high content of finely divided "active" iron oxides does not fit well in the "kandi" concept, and requires further study. In view of this, the "rhod" great groups and subgroups merit to be reviewed.
- Introduction of "kandi" great groups in the continental US is possible, according to J. Nichols, without too many drastic changes. According to a report of the committee on the amendments to the Soil Taxonomy-southern states, the break of 24 meg/100 g. clay for the CEC(NH_4OAc)

of the Bt horizon would bring all analyzed and tested soils of the Piedmont and Mountains, and most of the Upper Coastal Plain soils into the "kandi" great group, while the Udults of the Pamlico and Talbot terraces would fall outside of the "kandi" great groups. From Tennessee west to Arkansas and Oklahoma, the occurrence of "kandi" great groups diminishes; tested pedons in the latter two states have more than 24 meg/100 g. clay.

Summary of Comments

by- J. Vernon Martin

1. I am pleased to see so many other agencies and other countries represented at the conference.
2. The closing out or reorganization of committees for changing conditions is a step in the right direction.
3. I would like to see more participation of other disciplines from TSC's.

Conference Summary

My closing remarks will be brief. This is the first national conference I have chaired, I enjoyed it. We have had a" excellent conference. I appreciate the outstanding contributions from so many of you. I would like to give special thanks to William Austin; to Fred Merrill and Jerry Joiner, who did such a great job in guiding the field trip; and for the wonderful hospitality.

If I have any criticisms they are directed toward committee charges. Many of them were too broad and required a" excessive amount of work. Committees tend to breed new committees to take care of charges. Committees should not act like rabbits. New committees do not necessarily resolve anything. I believe, though, that the procedures recommended by Dr. McClelland's committee should resolve the difficulties.

Finally, I say thanks for the fine spirit of cooperation and for your support. I look forward to continued progress in soil survey and to seeing all of you again in two years. Thank you.

Klaus W. Flach
Assistant Administrator for Soil Survey

NATIONAL COOPERATIVE SOIL SURVEY

Soil Survey Conference Proceedings

Orlando, Florida
January 26-31, 1975

TABLE OF CONTENTS

Page

INTRODUCTION

The theme of the 1975 National Soil Survey Conference was "Better Soil Surveys for Improving Production and the Environment."

These conferences are designed to provide a forum for discussion of scientific and technical questions on soil classification, description, genesis, morphology, interpretations, and use. Reports of these conferences after trials and tests in the field become the basis for revising our technical manuals and procedures.

The conference is made up of representatives from the National, Technical Service Center, and State Offices of the Soil Conservation Service, other federal agencies having an interest in the soil survey program, as well as representatives from the Land-Grant Universities. In addition, Canada, England, Mexico, and the FAO had observers at our conference this year.

These proceedings contain the following:

1. Addresses to the Conference of Kenneth E. Grant, Administrator of the Soil Conservation Service, and George R. Bagley, President of the National Association of Conservation Districts.

2. Formal presentations to the conference of the representatives and observers of the organizations and agencies present at the conference.

3. The reports of the eight technical committees and the recommendations of the conference resulting from the discussions of these reports at the confernce.

These proceedings have no official status in their present form and should not be given widespread distribution. The information, ideas, and data in these proceedings simply represent trends in thinking and progress of work. Thus they do not necessarily represent official views although many of the methods ultimately may be adopted officially.

NATIONAL SOIL SURVEY CONFERENCE

January 26-31, 1975

Participants

(See explanation of abbreviations used at end.)

Name	Organization	Location
Anderson, James R.	USGS	Reston, VA
Arnold, Richard W.	Cornell U.	Ithaca, NY
Bagley, George R.	NACD	St. Joseph, LA
Balsley, James R.	USGS	Reston, VA
Bailey, Harry Hudson	U. of Kentucky	Lexington, KY
Bailey, Oran F.	SCS	Honolulu, HI
Barrows, Harold L.	ARS	Beltsville, MD
Bartelli, Lindo J.	SCS	WO
Booker, Wesley R.	BIA	WO
Cansino León, Alejandro	Sociedad Nacional de Agricultura	Mexico
Carlisle, Frank J.,Jr.	SCS	WO
Carter, Richard C.	SCS	Jackson, MS
Coover, James R.	SCS	Ft. Worth, TX
Daniels, Raymond B.	SCS	Raleigh, NC
Day, John H.	Soil Research Institute	Ottawa, ON, Canada
Dideriksen, Raymond I.	SCS	WO
Dudal, Rudy	FAO	Rome, Italy
Fenton, Thomas E.	Iowa State U.	Ames, IA
Ferwerda, John A.	SCS	Orono, ME

Name	Organization	Location
Flach, Klaus W.	SCS	WO
Flores Mata, Gaudencio	Secretaria de Recursos Hidráulicos	Mexico
Fuchs, Westal W.	SCS	Stillwater, OK
Gockowski, Jerome A.	SCS	WO
Grant, Kenneth E.	SCS	WO
Grossman, Robert B.	SCS	Lincoln, NE
Hagihara, James S.	BLM	Denver, CO
Harner, Rodney F.	SCS	E. Lansing, MI
Heil, Robert D.	Colorado State U.	Ft. Collins, CO
Hidlebaugh, Allen R.	SCS	WO
Jiménez López, Jorge	Secretaria de Recursos Hidráulicos	Mexico
Johnson, Robert W.	SCS	Gainesville, FL
Johnson, William M.	SCS	WO
Link, Victor G.	SCS	WO
Lloyd, William J.	SCS	WO
McClelland, John E.	SCS	WO
McKinzie, William E.	SCS	Lincoln, NE
Miller, Eilif V.	CSRS	WO
Nielsen, Gerald A.	Montana State U.	Bozeman, MT
Nowland, J.	Soil Research Institute	Ottawa, ON, Canada
Owens, Harold I.	ES	WO
Peters, W. B.	BR	Denver, CO
Post, Gerald J.	SCS	Columbus, OH

Name	Organization	Location
Rivera, Luis H.	SCS	San Juan, PR
Rodríguez Gómez, Rubén	Secretaría de Recursos Hidráulicos	Mexico
Rourke, John D.	SCS	Upper Darby, PA
Rourke, Robert V.	U. of Maine	Orono, ME
Ralston, David C.	SCS	WO
Salinas Duarte, Miguel	Sociedad Nacional de Agricultura	Mexico
Smyth, Anthony J.	Land Resources Division	Surrey, England
Stout, Maurice, Jr.	SCS	Lincoln, NE
Vanderford, Harold B.	Mississippi St. U.	State College, MS
Williams, J. Melvin	SCS	Portland, OR
Wertz, William A.	FS	WO
Young, Keith K.	SCS	WO

Abbreviations Used

ARS	Agricultural Research Service, U.S. Department of Agriculture
BIA	Bureau of Indian Affairs. U.S. Department of the Interior
BLM	Bureau of Land Management, U.S. Department of the Interior
BR	Bureau of Reclamation, U.S. Department of the Interior
CSRS	Cooperative State Research Service, U.S. Department of Agriculture
ES	Extension Service, U.S. Department of Agriculture
FAO	Food and Agricultural Organization of the United Nations
FS	Forest Service, U.S. Department of Agriculture
NACD	National Association of Conservation Districts
USGS	Geological Survey, U.S. Department of the Interior
WO	Washington Office

NATIONAL SOIL SURVEY CONFERENCE

January 26-31, 1975

AGENDA

Sunday January 26		
3:00-6:00 p. m.	Registration	Lobby Robert W. Johnson
Monday January 27 7:45-8:30 a. m.	Registration	Grove Room
	General Session - Grove Room William M. Johnson, Chairman	
8:30 a. m.	Conference Opening	
	Soil Survey - FAO	Rudy Dudal Chief, Soil Resources, Development, and Conservation Service, FAO, Rome, Italy
	Soil Survey - Canada	John H. Day Senior Soil Correlator Soil Research Institute Ottawa, Canada
	Soil Survey - Mexico	Ing. Gaudencio Flores Mata Director de Agrologia Secretaría de Recursos Hidráulicos, Mexico
10:05	Recess	
10:25	British Soil Surveys - Overseas	Anthony J. Smyth Director Land Resources Division Ministry of Overseas Development England
	Land Resource Analysis Programs - USGS	J. R. Balsley Assistant Director Research, USGS

Monday
January 27 (continued)

	Northeast Region Report	Robert V. Rourke university of Maine
11:45	Lunch	
12:45 p. m.	Southern Region Report	Harold B. Vanderford Mississippi State University
	North Central Region Report	Thomas E. Fenton Iowa State University
	Western Region Report	Gerald A. Nielsen Montana State University
	Soil Survey - Agricultural Research Service, USDA	Harold L. Barrows
	Soil Survey - Bureau of Indian Affairs, USDI	Wesley R. Booker
	Soil Survey - Bureau of Land Management, USDI	James Hagihara
	Soil Survey - Bureau of Reclamation, USDI	W. B. Peters
2:30	Recess	
2:50	Soil Survey - Cooperative State Research Service, USDA	Eilif V. Miller
	Soil Survey - Extension Service, USDA	Harold I. Owens
	Soil Survey - Forest Service, USDA	William A. Wertz
	Soil Survey Operations Division, SCS	J. E. McClelland
	Soil Survey Interpretations Division, SCS	L. J. Bartelli
	Soil Survey Investigations Division, SCS	K. W. Flach
	Land Inventory & Monitoring Division, SCS	R. I. Dideriksen

Monday
January 27 (continued)

	Cartographic Division, SCS	J. A. Gockowski
	Soil Survey Manual	Morris E. Austin
5:15	Adjourn	

Tuesday
January 28

Discussion of Committee Report8

Committee	
1	Modernizing Soil Survey Publications
2	Improving Soil Survey Techniques
3	Waste Disposal on Land
4	Water Relations in Soils
5	Techniques for Measuring Source and Yield of Sediment
6	Claaalflcation of Soils Resulting from Mining Operations and Interpretations
7	Kinds of Soil Survey8
8	Classification of Organic Soils and the Interpretations

Discussion of Committee Report8

	Group A	Group B	Group C	Group D
Room:	PALM	PINE	OAK	CYPRESS
	Committee	Committee	Committee	Committee
Time				
8:15 a. ❑ .	5	2	3	4
9:30	8	3	4	1
10:00		Break		
10:30	8	3	4	1

Tuesday
January 28 (continued)

	Group A	Group B	Group C	Group D
Room:	PALM	PINE	OAK	CYPRESS
	committee	Committee	Committee	Committee
Time				
11:15	3	4	5	2
12:00		Lunch		
1:00 p. m.	3	4	5	2
1:30	4	1	8	3
2:45		Break		
3:15	1	6	7	8
4:30	6	7	2	5
5:00		Adjourn		

Wednesday
January 29

Continue Discussion of Committee Reports

8:15 a. m.	6	7	2	5
9:00	7	8	1	6
10:15		Break		
10:45	2	5	6	7
12:00		Lunch		
1:00 p. m.		Tour		

4:00 Multimedia Shows "Underfoot" and "Circle of Life"
Courtesy of Information Division, Soil Conservation Service

4:45 Return to Motel

Thursday
January 30

Grove Room

Report of Committees

8:30 a. m.	Committee 1 Modernizing Soil Survey Publications Keith K. Young, Chairman
	Committee 2 Improving Soil Survey Techniques Victor G. Link, Chairman
10:00	Recess
	Committee 3 Waste Disposal on Land John D. Rourke, Chairman
	Committee 4 Water Relations in Soils Robert B. Grossman, Chairman
11:50	Lunch
1:00 p. m.	Committee 5 Techniques for Measuring Source and Yield of Sediment Allen R. Hidlebaugh, Chairman
	Committee 6 Classification of Soils Resulting from Mining Operations and the Interpretations Frank J. Carlisle, Jr., Chairman
2:30	Recess
	Committee 7 Kinds of Soil Surveys J. Melvin Williams, Chairman
	Committee 8 Classification of Organic Soils and the Interpretations William E. McKinzie, Chairman
4:20	Adjourn

Friday **January** 31	**Grove Room**
8:30 a. m.	National Association of Conservation Districts and the Soil Survey Program Address by George R. Bagley President NACD
9:00	Administrator's Message Kenneth E. Grant Administrator SCS
10:00	Recess
10: 20	Conference Summary William M. Johnson Deputy Administrator for Soil Survey SCS

CONFERENCE PRESENTATIONS

NAME OF AGENCY

SCS

ACCOUNTING CLASSIFICATION

THIS BLOCK FOR USE OF COMMUNICATIONS UNIT

PRECEDENCE

ACTION

INFO

TYPE OF MESSAGE

SINGLE

BOOK

MULTI ADDRESS

SECURITY CLASSIFICATION

STANDARD FORM 14 REV. MARCH 15 1957
GSA REGULATION 2-IX-201.04
14-301

TELEGRAPHIC MESSAGE

OFFICIAL BUSINESS
U. S. GOVERNMENT

MESSAGE TO BE TRANSMITTED (Use double spacing and all capital letters)

THIS COL. FOR AGENCY USE

TO: BILL JOHNSON, DEPUTY ADMINISTRATOR FOR SOIL SURV:
SCS, WASHINGTON, D. C.

Please accept my sincerest regrets for not being present this morning. Have looked forward to this for several months, but circumstances require my presence elsewhere.

Your deliberations are indeed important to rational land use decision making in America. Planners need sound technical data from which to select best alternatives -- commencing with the very foundation of soils.

Best way to express the seriousness and importance of your task is to quote the late Adlai Stevenson who said:

"There is a new America every morning when we wake up. It is upon us whether we will it or not. This New America is made up of many small changes: a new school here, a new industry there, a new factory where yesterday there was vacant swampland. All of these changes add up to a broad transformation of our lives, Our task is to guide those changes, for though change is inevitable change for the better is a full time job."

Best wishes for a highly productive conference.

DO NOT TYPE MESSAGE BEYOND THIS LINE

PAGE NO. | NO. OF PAGES

NAME AND TITLE OF ORIGINATOR (Type)

William L. Vaught, Field Represent9

ORIGINATOR'S TEL. NO.

DATE AND TIME PREPARED

SECURITY CLASSIFICATION

I certify that this message is official business, is not personal, and is in the interest of the Government.

15

(Signature)

Soil Resource Investigations in Canada

John H. Day
Canada Department of Agriculture,
Ottawa, Ontario

I am very pleased to be here with my colleague Mr. John Nowland. Mr. Nowland is our correlator for the provinces of eastern Canada. I wish to thank you for extending to us the invitation to participate in this work planning meeting. And on behalf of my other colleagues I thank you for the opportunity to be involved in the work of the organic soil task force.

During the last two years we have, of course, continued with our standard reconnaissance soil survey program. In urbanizing areas where competing demands for land are pressing, we conduct detailed surveys. In remote areas we conduct smaller scale, or exploratory, survey, e.g., the pipeline corridor in arctic, hydroelectric power development areas.

In the field of soil classification the major development has been the proposal to classify soils that have permafrost within one meter of the surface in some part of the pedon. They are the dominant soils in the zone of continuous permafrost, have their maximum development in organic and poorly-drained, fine-textured mineral soils, Three major kinds of Cryosolic soils are recognized at the Great Group level. These are:

1) Mineral soils displaying marked cryoturbation and generally occurring on patterned ground.

2) Mineral soils without marked cryoturbation,

3) organic soils.

Order	Great Group	Subgroup	Subgroup modifier
9 Cryosolic	91 Turbic Cryosol	9101 Brunisolic Turbic Cryosol	5 Saline
		9102 Regosolic Turbic Cryosol	9 Lithic
		9103 Gleysolic Turbic Cryosol	
	92 Static Cryosol	9201 Brunisolic Static Cryosol	5 Saline
		9202 Regosolic Static Cryosol	9 Lithic
		9203 Gleysolic Static Cryosol	
	93 Organo Cryosol	9301 Fibric Organo Cryosol	9 Lithic
		9302 Mesic Organo Cryosol	10 Glacic
			11 Terric
		9304 Humic Organo Cryosol	

The Brunisolic, Regosolic, Gleysolic, Fibric, Mesic and Humic subgroups intergrade to the respective mineral and organic soil. The glacic subgroup modifier is used with layers that contain 95% or more of ice and are more than 30 cm thick within the 1 meter control section.

The implication of the adoption of this order, after the completion of the testing period, is that adjustments of six order definitions will be required end cryic subgroups will be deleted.

Another project in hand is the development of a landform classification system for use in conjunction with soil mapping. Schemes developed separately for mineral and organic landforms are in the later stages of evolution and will be merged.

The mineral landform system can be used without expert knowledge of geomorphological processes, although the basis genetic types are used for a ninefold compositional breakdown, e.g., morainal, lacustrine, fluvial rock. The surface form of each of these divisions is classified in terms of configuration (e.g., ridged, rolling, pitted) smoothness and inclination. Veneered forms and a variety of erosional modifiers are recognized, Versions of the system have been successfully integrated with soil mapping notably in the provinces of British Columbia and Saskatchewan.

The systematic approach to mapping organic soils in their landform setting was developed mostly in the province of Manitoba. Tt recognizes the close relationship between water chemistry and peatland surface form, and is well suited to surveys where ground checking is limited.

Our attempts to develop a soil information system (CanSIS) arc succeeding. Seven computer files are concerned with soil profile descriptions, soil maps, soil management, soil degradation, etc. The soil data, soil cartographic and soil names files are now operational. Although much work remains to develop these files further, data can be input, manipulated and retrieved. Digitizing equipment is operative and soil maps are now digitized as a normal cartographic operation. This will greatly facilitate soil survey operations and analyses of data by producing acreages, legends and interpretive maps for land evaluation automatically on the computer.

The scope of the CanSIS system is expanding; a number of provinces are establishing their own compatible hardware and software, National Parks will be using CanSIS for resource inventories. An international Soil Data Exchange project has been initiated with french-speaking countries.

YOU know that the International Society of Soil Science Congress 1978 will be held in Edmonton, Alberta. The executive committee is alive and working. The soil tours committee is organizing to undertake tour route selection this spring, soil site and sample selection during the summer.

Tours will cover the southern part of Canada from east and west coasts to Edmonton, and from Edmonton to the Arctic coast, There are to be eight precongress tours, four midcongress tours near Edmonton, and nine postcongress tours. The longest trip of 15 days would combine three tours in eastern Canada.

HYDRAULIC RESOURCES SECRETARY
GENERAL DEPARTMENT OF INVESTIGATION
SOIL SURVEY ADMINISTRATION DIVI SION

SOIL SURVEY ADMINISTRATION DIVISION ACTIVITIES IN MEXICO.

Ing. Gaudencio Plores Mata

January, 1975.

SUMMARY

The directors of the Soil Survey Administration Division of the Hydraulic Resources Secretary of Mexico want to sincerely acknowledge the kind invitation to assist to this National Soil Survey Conference, made by Dr. William M. Johnson, the United States Department of Agriculture's Deputy Administrator for Soil Survey.

The Hydraulic Resources Secretary has as one of its objectives, the development of irrigation projects all over Mexico, for which the Soil Survey Administration Department is carrying out soil investigations in the different categories such as: reconnaissance, semi-detailed, detailed and special. These investigations have well defined objectives within irrigational agriculture and are carried out with specified procedures.

This folder contains a brief description of Soil Surveys work done by the Soil Survey Administration Division in Mexico.

ANTECEDENTS

The Comisión Nacional de Irrigación (CNI) (National Irrigation Commission) was founded on January 4, 1926. It was a branch of the Secretaria de Agricultura y Fomento (SAF) (Agriculture Development Secretary) and was created at the same time as the Irrigation Act, that asigned the National Irrigation Commission to plan, construct, colonize and operate the national irrigation districts.

The Departamento Agroeconómico (Agricultural Economy Investigation Department) was created the same year, as part of the National Irrigation Commission. Its main purpose was to improve the utilization of soil in the irrigation projects. This Department has changed its name on several occasions, until it has become the Dirección de Agrologfa (Soil Survey Administration Division).

The period that this report will cover, is between 19261974, that is, approximately 48 years. We shall divide this span into three stages: from 1926 to 1946, from 1947 to 1966 and from 1967 to 1974.

First Stage (1926-1946). This stage includes the creation of the National Irrigation Commission and takes us up to the founding of the present Secretaría de Recursos Hidráulicos (SRH) (Hydraulic Resources Secretary). During this stage, the Agriculture Economy Department hired North American Technicians in order to train Mexicans in this field. This Department acquired valuable experience during this stage and carried out investigations in soil classification, in several different states of the country. At the same time, Regional Laboratories for Soil and Water Analysis were created,

However, we would like to mention that, during this period, there were critical stages where the initial effort slowed down and this was reflected by low production in the irrigation districts. This also indicated the need for continuous basic soil surveys for all the irrigation projects.

Second Stage (1947- 1966). This stage begins with the creation of the Hydraulic Resources Secretary. The Agricultural Economy Department changed its name to Departamento de Agrologfa (Soil Survey Department), Sixty technicians participated in the continuation of this work.

Durding this period, the soil surveys made, were included as a part of the requirements set by the Bancos Internacionales de Crédito (International Credit Banks), These banks required the use of new methods for making soil surveys, and so, within the Soil Survey Department, a Photogrammetry and Photo-interpretation Office was created, Third Stage (1967-1974). In order to carry out soil survey investigation systematically, for large and small irrigation projects, the Hydraulic Resources Secretary created the Soil Survey Administration Division in May, 1967.

In this way, the new Soil Survey Administration Dlvision has directed its objectives toward the systematic realization of soil survey investigation as a part of the basic studies made for irrigation projects,

GOALS OF THE SOIL SURVEY ADMINISTRATION DIVISION

Soil Survey investigation is part of a general program of activities carried out by the General Department of Investigation, They form part of other basic research that is necessary for the correct planning of the different irrigation projects that the Hydraulic Resources Secretary is making throughout the country.

Soil studies are subdivided in: reconnaissance, semi-detailed, detailed and special. These technical documents are elaborated with well defined methods and objectives. These are made up of two equally important parts, the technical memorandum and their corresponding soil maps.

The soil survey maps contain the localization and extention of the unites called series, types and phases as well as the kinds of soil to be used with irrigation,

The information that is described in the technical memorandum, refers mainly to the general pedological and hydrodinamic characteristics of soils. This data is related to the taxonomic or interpretational units that are show on the land maps.

The principal data that is provided by the soil survey is the following:

1. Soil Classification maps in series, types and phases.

2. Classification of land to be used in agriculture with irrigation (6 categories).

3. Water quality in irrigation,

4. Irrigation methods, water depths, etc.

5. Cultivation programs.

6. Preventive measures against saline soils.

7. Agricultural drainage needs.

8. Preventive measures against erosion.

9. Soil management.

10. Bases for determining soil capacity use (8 categories).

The investigation procedures used for soil surveys done by the Soil Survey Administration are the following:

1. General specifications for the different kinds of soil investigations.

2. Field data instructions.

3. Methods for water and soil sample analysis.

4. Methods for making reconnaissance, semi-detailed, detailed and special soil surveys.

5. Climate calculation instructions.

6. Aerial photograph specifications.

7. Specifications for chart elaboration.

8. Instructions for determining hydraulic conductivity (drill method).

9. Linear programming system for planning crops.

10. Petrographic analysis, chromatographs and electronic microscopy

The following are International work norms that are used as a basis for the elaboration of soil surveys:

1. Soil Survey Manual, US Department of Agriculture.

2. Irrigation Suitability Classification Bureau of Reclamation Manual, US Department of the Interior.

3. Land Capability Classification, Soil Conservation Service US Department of Agriculture.

4. Diagnosis and Improvement of Saline and Alcali Soils (Handbook 60), US Dept. Agr. Regional Salinity Lab. Riverside, Calif.

5. Salinity in Relation to Irrigation, Regional Salinity Laboratory Riverside, Calif. USA.

6. International Institute for Land Reclamation and Improvement Wageningen The Netherlands.

7. A Field Method for Measurement of Infiltration US Geological Survey.

8. The Auger Hole Method, International Institute for Land Reclamation and Improvement. Wageningen The Netherlands,

9. US Coast and Geodetic Survey Special Publications, US Department of Commerce,

10. Manual of Photogrammetry and Photointerpretation. American Society of Photogrammetry.

Organisms that are served by the Soil Survey Administration,

The information that is contained in the soil surveys, is presented in technical publications that are requested mainly by government offices that are carrying on agricultural development projects within the country.

At the same time there is also permanent public service available,

THE ORGANIZATION OF THE SOIL SURVEY ADMINISTRATION DIVISION

For carrying out the different jobs that are given to the Soil Survey Adminstration Division, we have the following organizations,

<u>Central Offices in Mexico City</u>

Direction

Soil Department

Special Investigation Department

Laboratories Department

Agricultural Department

Soil Chart Department

Publication Department

Administrative Department

Photographic and Cinematographic Laboratory

11 Field Staff and installation units throughout Mexico

12 Laboratories for soil and water analysis throughout the country.

5 Mobile field staff and equipment units.

25 Experimental fields spread out in all parts of the country.

Technical and administrative staff of the Soil Survey Administration Division.

Agronomists with different specializations	75
Chemical Engineers with different specializations	26
Civil Engineers	6
Physic-Mathematicians	6
Economist and Geologist	12
Technical Librarians and Translators	6
Qualified draftsmen	15
Administrative Personnel	40
T O T A L	213

SOIL SURVEY STUDIES MADE DURING 1971-1974

The following are soil survey investigations in Reconnaissance, Semi-detailed, Detailed and Special categories that were made in this period:

	1 9 7 1		1 9 7 Z		1 9 7 3		1 9 7 4	
	NO, 0E studies	Ha	NO, 0E studies	Ha	NO, 0E studies	Ha	NO, 0E studies	Ha
Big Irrigation	9	Z79 529	12	1 444 874	32	1 069 852	24	1 416 167
Small Irrigation	80	145 872	104	131 916	128	74 967	589	321 323
TOTAL	8 9	425 401	116	1 576 700	160	1 144 819	613	1 737 490

TECHNICAL PUBLICATIONS

During 1971-1974 the Soil Survey Admlnstration Division has made 978 Soil Survey studies in the four established categories (reconnaissance, semi -detailed, detailed and special) of which 17 have been published in a serie that is listed below with a total of 11 200 copies,

SERIES	PUBLICATIONS	PRINTING
Studies	6	4 500
Publications	6	3ooo
Miscellaneous	5	3700

INTERNATIONAL TECHNICAL EXCHANGE

The Soil Survey Administration Division has made some investigations together with other international organisms, above all in the fields of geomorphology, classification, and soil genesis in the Mexican Republic. Some outstanding examples of these are:

- Soil Unities of Mexico - by FAO System,
- Soil Classification of Chihuahua State (7th approximation),
- NASA-USA.
- Regional Salinity Laboratory Riverside, Calif. USA.
- ORSTOM, France.
- Wageningen, The Netherlands.
- The Soil Center International: Gante, Belgium.

Postgraduate studies have been made by technicians of the Soil Survey Administrative Division in the following countries:

USA	Brazil
Holland	Colombia
Canada	Peru
France	Argentina
West Germany	Panama
Israel	

BRITISH SOIL SURVEY OVERSEAS

by

A J Smyth

Lend Resources Division, Surbiton, UK.

I regret that the title of my talk is doubly misleading. In the first place it suggests an intention to discuss all British soil survey work abroad whereas I plan to speak only about the work of the Land Resources Division of the UK Ministry of Overseas Development. Thus I will be ignoring the very considerable efforts and achievements of British soil surveyors working overseas for commercial firms, universities and other organisations, both in the present and in the past. Secondly, to many people especially perhaps to an American audience, the term 'soil survey' may have a rather different connotation from the activities of Land Resources Division which I am about to describe.

History and Objectives of Land Resources Division[1]

The Land Resources Division (LRD) was formed within the Directorate of Overseas Surveys in 1964 by combining the UK Pool of Soil Scientists with the Forestry and Land Use Section of the Directorate, but the roots of these formative units can be traced back about twenty years to the immediate post World War II period. In 1971 LRD became an independent scientific unit contributing to the British Overseas Aid Programme.

The primary objective of LRD is to assist Governments of developing countries to evaluate their land resources with the longer term view of accelerating rural development on a sound basis. The aim is to study land in all its aspects - approaching as closely as possible to a study of physical reality. Thus although the Division is not large its range of specialists is varied. The core staff comprises some sixty scientists most of whom have extensive overseas experience in such fields as soil science, ecology, geomorphology, forestry, hydrology and various aspects of agriculture including agronomy, animal production and agricultural economics. The largest single group is, in fact, the soil scientists. This core staff can be supplemented by specialists engaged on contract to carry out specific projects.

LRD staff are currently working, or completing work in 15 countries of which 5 are in Africa, 5 in Central America and the Caribbean, 4 in Asia and the Far East and one in the Pacific. Not all of the projects involve a significant element of soil science for they include forest inventories and agronomic studies. Soil survey does play an essential part, however, in the Division's largest current projects in the Yemen Arab Republic and in Central Nigeria. The Central Nigeria project employs five soil

(1) Described in some detail by Baulkwill (1972)

surveyorsand calls for land resource survey of an area of more than go 000 square miles. When this project is completed towards the end of 1977LRD will have surveyed over 200 000 square miles of Nigeria at reconnaissance level - more than half of the total area of the country (see Fig. 1).

LRD's Approach to Resource Assessment

All of the areas studied by LRD lie outside the United Kingdom. Nevertheless, it is convenient and economic to carry out some stages of the work at our headquarters at Tolworth, some 15 miles south-west of London. A procedure that makes this possible has been developed.

Requests for assistance from overseas governments ore transmitted to London by our Embassies or High Commissions abroad. In London the requests are considered by the relevant Geographical Departcents of the Ministry of Overseas Development and, if appropriate, LRD may be asked to undertake a project appraisal to determine the best way of providing assistance.

A project appraisal usually involves a visit, to the country by three or four specialists in different disciplines and, depending on the size and complexity of the problem, may take a fen weeks or several months to complete. This work gives rise to specific project proposals and if these are favourably received by the overseas government a land resource study is started.

Three principal stages can be distinguished in a typical LRD project:

1. Project preparation in the UK
2. Overseas field work
3. Data processing and reporting in the UK

The preparatory work in Britain is concerned largely with air photo interpretation and a preliminary definition is made of landscape units in the project area. Preliminary maps are made and stores and equipment are sent abroad. In addition special efforts are made by the LRD information service to obtain all relevant existing literature for study by the project team. In recent years and for the larger projects this activity has led to the preparation of special bibliographies which have been published on a limited scale.

The nature of the field work abroad varies very greatly, of course, in relation to the objectives and physical conditions of tie project. Basically, the Division follows a method of landscape analysis pioneered by the CSIRO, Australia (described most fully in Christian and Stewart 1968).

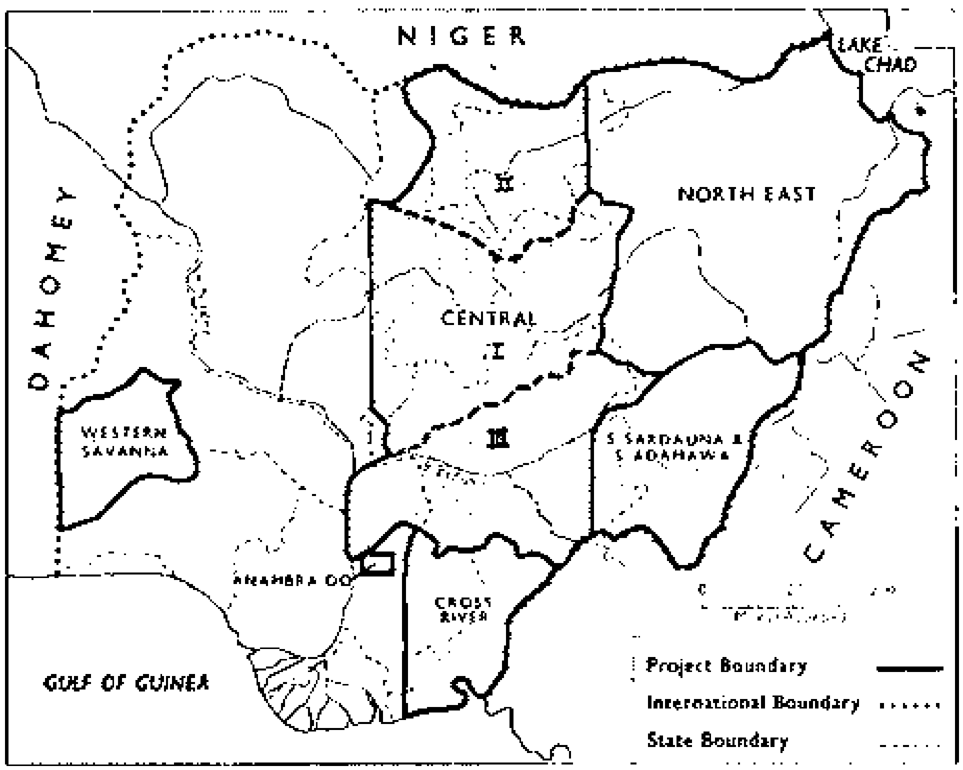


Figure 1 : Location of the current Central Nigeria Land Resources Survey Project (stippled) and areas covered by previous Land Resources Division reconnaissance survey projects in Nigeria.

Amongst resource survey organisations LRD is somewhat exceptional in pinning its faith 50 firmly to this method but we believe it offers a number of advantages, especially for rapid survey of large area5 with difficult access. Not least of these advantages is the extent to which the method encourage5 a team approach and, indeed, compels a degree Of integration between scientific disciplines in the assessment of land.

The method leads to division of the surveyed region into land systems, which are fairly large unit5 of landscape having characteristic patterns of relief, soils and vegetation. If the intensity of study permit5 the land system5 are subdivided into land facets, units of the landscape having individual significance in relation to existing and potential land use.

The land system5 and land facets are described in terms of the various landscape component5 (Geomorphology, soils, vegetation end land use) which are examined in the field in varying detail depending on the overall intensity of the study. Table 1 illustrates the level of categorisation aimed at in LRD surveys of differing intensity. Usually the boundaries between the mapped units are determined by landform criteria and only in very intensive studies or where soil changes of great practical consequence occur (eg: between sandy Entisols and Vertisols) would soil boundaries per se be traced.

In several LRD projects, however, very intensive soil survey5 of sample areas have been carried out to obtain a better understanding of the relationships between soils and of the distribution of soils within the larger landscape units.

During the course of field work samples of 50115, vegetation and water are sent to the United Kingdom for analysis, the soil samples being handled by the Tropical Soils Analysis Unit whioh is part of LRD.

To an increasing extent so&o-economic, agricultural and forestry studies proceed in parallel with the survey of the landsoape to provide a basis for sound interpretation of the survey findings.

On completion of the fieldwork an interim report on the findings of the study is sent to the recipient government but the projeot is by no means over. In the final stage, back in UK, the project team obtain5 a major assistance from supporting services at headquarters - information retrieval, computer, cartographic, laboratory and publishing services. Data processing by computer play5 an increasingly important role in all aspects of landsoape and sooio-economic analysis. The Division oan also draw upon a fund of specialised overseas knowledge and experience not only within its own Ministry but also at many British universities and scientific institutions. LRD is particularly fortunate to be able to rely upon its erstwhile parent, the Directorate of Overseas Surveys, for final map production and for almost day to day liaison with LRD's own Cartographic Unit in the initial compilation stages. The findings of the larger projects are published a5 one of a series of LRD Land Resource Studies eaoh of whioh includes a rang8 of maps.

Survey type and typical area covered (mi²)	Objective	Typical map scale	Landscape analysis	Landscape components*				Economic analysis
				Geomorphology	Soil	Vegetation	Land use	
1. Reconnaissance. More than 2,000. May be as large as 100,000	National or regional inventory	1:250,000 and 1:500,000	Land systems or higher categories	Major relief units	Order, sub-order, great soil group or associations	Climatic and edaphic formation types	Agroecological groups	National or regional economy
2 Extensive. 1,000–10,000	Detailed inventory: broad assessment of agricultural potential	1:100,000 to 1:250,000	Land systems	Relief units or major landforms	Great soil groups, or associations of series	Climatic and edaphic formation types and plant associations	Land use systems and cultivation density	Regional economy and/ or sector analysis
3. Intensive. 500–5,000	Location and definition of development projects	1: 25,000 to 1: 100,000	Land systems and facets	Detailed landforms	Series or associations of series	Plant associations	Land use and farming systems, plus specific parameters	Sector analysis including market prospects and cost-benefit analysis of development projects
4. Development study. Usually more than 50	Resource analysis and development planning	1:10,000 to 1:25,000	Land facets and elements	Landform elements or slope units	Phases of series and/or selected parameters	Plant associations and species distribution	Specific parameters, eg crop distribution, field patterns	Detailed examination of development projects, cost-benefit analysis and commodity studies

* These components may be mapped individually in some surveys.

Table 1 : Levels of categorisation in principal types of LRD survey (from Baulkwill, 1972, based on Stobbs, 1970)

Guadalcanal : An Example of an LRD Land Resource Study

The details of methods of soil study and mapping used in LRD projects have varied very greatly, partly because of differing project objectives, partly to meet differing environmental conditions and partly to explore with varying success new ways of overcoming the problems of survey in less developed areas. No single survey can be regarded as typical, therefore, and in choosing the land resource survey of Guadalcanal as an example of LRD's work I confess I have been influenced by the interest which this famous name can be expected to arouse in an American audience.

The island of Guadalcanal which covers 5 730 km^2 was mapped by LRD between March 1967 and June 1968 as part of a five year programme to map the 28 420 km^2 of the British Solomon Islands. The aim of the survey was to determine areas of land with agricultural potential and to provide basic data on the soils, topography, current and potential land use of these areas. Taking account of the rugged terrain and the virtual absence of roads (96 km only along the northern coast) the land system approach was thought to be the only possible means of obtaining the required answers within the time available.

Apart from the northern plains and a few river valleys most of Guadalcanal is hilly to mountainous with a main ridge rising on average to 1 500 m and culminating in peaks at 2 330 m end 2 450 m within 15 km of the southern coast. Daytime temperatures exceed 25°C throughout the year, humidity is high and rainfall varies from 3 000 mm on the northern coast to >13 000 mm in some years on the southern coast.

Fortunately air photographs at scales of between 1:40 000 and 1:60 000 and maps with 40 m form lines were available for the whole island. These were used to produce a breakdown of the landscape into 43 land systems on the basis of topography and vegetation.

Two weeks in each month were spent in fieldwork. Up to four parties worked from a coastal base camp and moved by ship or dinghy along the coastline to the starting point of each day's work. Incised rivers subject to flash flooding and steep, unstable, often precipitous slopes restricted routes to inter-village footpaths, hunting tracks or valley sides and only rarely was traverse cutting resorted to on the reconnaissance survey. The routes were chosen to reach areas characteristic of the land system and the distance travelled by a party in one day averaged 5-10 km with a maximum of 25 km. Sites were selected along the routes on a subjective, non-random basis with the aim of describing as many facets of the land system as possible.

Because of the hilly nature of the terrain and the overall dense forest cover, the routes had to be checked continually by reference to the air photographs and by comparing altimeter readings with the contoured maps. Even so precise location of sample sites was the exception rather than the rule. Generally 6-10 site descriptions were made each day. They represented as many different land facets as possible but because of the orientation of paths along the more accessible routes, sites near ridge crests tended to predominate. At the selected sites, augerings of soil profiles were fully described. Slope end altitude readings of the site were supplemented by records of adjacent slopes, relief and the ground condition of the area, erosion, gullying, rock outcrops, land use and vegetation. After some days in an area representative sites would be selected and soil pits dug, described and sampled. On Guadalcanal 3700 soil augerings were made and 187 pits were sampled.

The broad groupings of soils recognised were described and mapped a8 Soil Associations and the most extensive soils in these associations were correlated with the US Soil Taxonomy.

From the reconnaissance fieldwork it was possible to decide which provisional land systems had some agricultural potential and from them representative sample areas were chosen. These area8 were studied in detail in order to investigate soil/topographic relationships and to check the areal distribution of soils.

The sample area8 varied in size between 40 and 80 acre8 and were defined by traverses 200 ft. apart and between 3 000 ft and 4 500 ft long out on a grid system. The area was accurately surveyed using an engineering level and maps with contour intervals varying between 1 ft and 20 ft were produced depending upon the nature of the terrain. Soil.3 were described at 100 ft intervals along the traverses and samples taken from the most widespread kinds of soil. The detailed information on the soils of these representative areas was presented in a series of maps showing single soil characteristics suoh as 80118, soil depth, drainage, stoniness, depth of humus horizon and land use.

For the island as a whole the following maps were produced:

at 1:250 000 scale

(a) Physiography and physiographic regions

(b) Catchment areas

(c) Soil sample sites and traverses

(d) Soil associations

at 1:150 000 scale

(e) Land Systems and Land Regions

(f) Land use(1962-1971)

(g) Agricultural opportunity areas (areas in which present land use is markedly below physical potential)

(h) Forest types

Some Special Problems and Resulting Trends in Land Resource Surveys

In conclusion I would like to speak briefly about the special problems which face LRD and similar organisations carrying out resource surveys overseas in developing countries. These problems can be summarised under three headings:

1. Objectives and programming
2. Accessibility and logistics
3. Interpretation and application of survey findings

Objectives and programming:

Unlike many national soil survey organisations, LRD has no long term, routine programme of work for which a high degree of standardisation can be developed. Each of our operations is a unique response to a request for aid. Terms of reference must be prepared on each occasion to define the objectives of the study and the means by which these objectives will be achieved. Lack of technical expertise in the countries which we serve is the reason for our Division's existence and it follows that much of the responsibility for defining the objectives and methodology of our projects falls on our own project appraisal teams. Much of the time of senior staff in the Division is devoted to this work. Occasionally, perhaps increasingly, such work is an end in itself, leading to the preparation of Terms of Reference for projects which an overseas government may submit to commercial consultants or to other sources of bilateral or multilateral aid.

A large proportion of LRD's work has been at reconnaissance intensity, for many developing countries lack the broad knowledge of resource potential necessary to decide the most fundamental aspects of land use policy. In developed countries these basic questions have often been answered by farming experience and where this proves inadequate a broad picture of resource distribution can often be synthesised from large amounts of data derived from years of intensive surveys. Time is too short for this approach to serve the developing countries. Once a need has been identified, environmental data, including soils data, must be obtained as quickly as possible or planning will proceed without it - such is the urgency for development. This implies that environmental conditions must be summarised on the basis of a minimum of observations and Samples. This, in turn, places special demands on the calibre of the survey team - above all they require relevant experience. I have already emphasised the overseas experience of the LRD staff but this is largely a legacy of colonial history and the problems of training youthful replacements for these men are very considerable.

A change in the pattern of LRD's work is discernible for there is a tendency for the proportion of more detailed studies to increase. This trend is understandable, for the 'Development Studies' produce an actual blueprint for the implementation of development and help to meet the current need in most countries to produce 'bankable' projects. Economists and financiers are less eager to invest in small scale reconnaissance studies for in themselves these yield relatively few opportunities for immediate development, There are obvious dangers, however, in jumping too quickly to the Development Study - in attempting to answer the question 'how' before the question 'where' has been adequately answered.

Associated with the greater emphasis on Development Studies has come a gradual change in the priority accorded to soil survey in relation to other aspects of an integrated environmental study. Experience has demonstrated that if the location and objectives of proposed development have been chosen with reasonable care then studies of sociology, marketing, water supply and perhaps other factors may have a more important bearing on economic and practical feasibility than the findings of soil survey. on the other hand, once feasibility is determined, soil survey has a major role to play in farm planning and in guiding land management.

In general, the economist is playing an increasingly important part in LRD work - not least in helping to define the objectives of the work before actual inventory begins.

Accessibility and logiatioa:

Guadalcanal provides an excellent example of the difficult terrain in which LRD is commonly called upon to work, Equally good examples could be quoted from Nepal or Sabah. The phyaioal problems associated with such difficult access are obvious and to these must be added the usual problem5 of accommodation, transport end equipment maintenance associated with life in developing areas; all of whioh requires that a disproportionate amount of staff time must be used in purely organisational matters.

.Difficulties of access also exert a controlling influence on survey methods. They place limitation5 on the types of modern equipment that can be used either beoauae of weight or size (eg: powered augers or diggers) or because of problems of sensitivity, calibration or maintenance (eg: neutron moisture probes), On the other hand aooeaa problems together with shortage of skilled assistants have encouraged trial use of automated recorders, notably automatio weather stationa, with promising results.

Above all, difficulties of access have enoouraged maximum use of air photo interpretation in LRD surveys. Conventional panchromatic black and white aerial photography remains the mainstay of our work but other forms of imagery are used and a watchful eye is kept on advances in the field of remote sensing.

Interpretation and Application of Survey Findings:

A major oonoern in organiaing land survey5 overseas is to ensure that the findings will be put to effective uae. The result5 of the survey need. to be reported in a form that will be of greatest immediate value to potential user5 but, in addition, specific effort5 need to be made to bring the report to the user's attention and to explain its significance. Dealing with this latter point first, LRD has made it a practice for a team leader and perhaps some of his colleagues to return to a country to present their completed report to the government and also to hold what might be termed an "induction seminar" at which local staff at appropriate levels are instructed in the use of the report. Increasingly in future it is likely that a member of the project teem will remain in the country for as much as a year after completion of a large survey to assist in integrating survey findings into the government's planning process.

Concerning the form of the report it is apparent that special attention should be paid to interpreting the scientific information in terms that will be readily understood by the principal users and that recommendations and practical interpretations should be prominently placed separately from material of a purely reference nature. The trend is for interpretations to take the form of clear cut recommendations of the suitability of land for rather specifically defined forms of lend use known to be of interest to planners in the area. An individual tract of land is likely to be suitable for more then one use and if guidance is to be given in choosing between uses an attempt must be made to express the different suitabilities in quantitative economic terms. Weedless to say this presents special problems in the developing lands of the tropics where all forms of quantitative data are scarce.

In the field of soils the desire to assess potential productivity quantitatively has aroused new interest in parametric methods of soil interpretation - an interest that is doubtless stimulated by more widespread availability of computers and a greater familiarity with statistic81 methods and model building amongst soil scientists. Certainly the need exists for rapid means of assessing potential productivity under defined conditions from measurable characteristics of the soils and other environmental attributes.

The means of interpretation must be rapid for if the assessments are to relate to specific uses and are to take account of economic criteria their useful life will be very short. Indeed they may have to be up-dated with subtle changes at frequent intervals returning each time to the soil and other basic surveys for the baseline data. Nobody imagines this will be easy but I personally am convinced that it is the direction in which we must go. We must carry out knowledge of soils and land more than halfway to the planner if we want to ensure that these precious resources are wisely used. This, I believe, is what our work is all about.

Acknowledgement:

Having only recently joined Land Resources Division it is apparent that, although the views expressed are my own, the work described is that of my colleagues and I am particularly indebted for material provided by Mr W J Baulkwill, Mr J R F Hansell and Mr A R Stobbs.

References:

Baulkwill, W J (1972) "The Land Resources Division of the Overseas Development Administration". Vol. XIV No.4 Tropical Science.

Christian, C S and Stewart, GA (1968) "Methodology of Integrated surveys" Proceedings of a Conference on Aerial Surveys and Integrated Studies (Toulouse 1964) UNESCO, Paris.

Stobbs, A R (1970) IV. Soil survey procedures for development purposes. In New Possibilities and Techniques for land use and related surveys. Cox, I H (Ed.) Occ. Pap. Wld Land Use, No.9, u-63.

LAND RESOURCE ANALYSIS PROGRAMS OF THE U.S. GEOLOGICAL SURVEY

J. R. BALSLEY

I am very pleased and honored to be invited to the National Soil Survey Conference to discuss with you the Land Resource Analysis Programs of the United States Geological Survey. Traditionally, the Geological Survey has been interested in assessing the mineral resources of the United States and for that reason has concentrated most of its research and activities on the bedrock. As I understand it, the Soil Conservation Service has traditionally been dedicated to soil and water conservation related to agriculture and has concentrated on the soils. Now that the Nation as a whole has recognized the value of our land resource and recognized the need to know more about it to be able to make wise decisions as to its best "se, we must learn more about the material that lies between the bedrock and the surface soil. Our two organizations share the major responsibilities of meeting this need, and recognizing this, we have for many years been conducting informal exchanges. Many of you in the field offices know of these joint activities of the USGS and SCS. Our two organizations are about the same size and both conduct extensive field operations. As is the case in most organizations of this type. the field men feel that the Washington headquarters office doesn't know what's really going on, and they're probably right. But we do get together, even in Washington, and have now established a formal SCS-USGS Coordination Committee to improve and expand this cooperation. This group meets every two months under the leadership of Bill Johnson from the Soil Conservation Service and Frank Clarke from the USGS. Subcommittees on special topics meet more frequently and to give you a flavor of the content of our discussions, I'll give you a quick rundown of their titles. The ERTS-Mosaic Reproduction Subcommittee has already moved forward with the printing on U. S. Geological Survey presses of the Soil Conservation Service 1:5,000,000 mosaic of the NASA ERTS photography. This is to make your band 5 and 7 summer scenes of the U. S. available at only $1.25 a copy. These should be ready by March 15. You may not have heard that the ERTS satellite has now been renamed LANDSAT, so we'll have to get used to a whole new set of initials. There is a subcommittee on Wetlands, which is concerned with their definition and methodology of their study; another on the coordination of mined-area reclamation programs; another on the coordination of our Land Use Data and Analysis program activities with the land-use mapping needs of Soil Conservation Service. There is a subcommittee on publication of flood-plain maps which has arranged for the USGS presses to print Soil Conservation Service flood-plain maps. Other subcommittees deal with the coordination of air photo needs, the interagency coordination of peak flood flow estimates and procedures, the Federal Water Data Coordination program in relation to the Soil Conservation Service needs, and the joint District of Columbia Soil Survey.

Many of you are undoubtedly familiar with our organization but I would like to review it briefly and then discuss the various ongoing programs that may be of interest to members of the Soil Conservation Service.

We have four main operating Divisions: the Geologic, Conservation, Water Resources, and Topographic. We also have support Divisions: the Administrative, Computer Center, and the Publications Division; the latter is involved not only with our book publications but operates a major map printing plant.

The Geologic Division is responsible for studying the earth in three dimensions with particular emphasis on evaluating mineral resources including petroleum. It is also involved in the study of natural hazards including earthquakes, landslides, and volcanoes and it conducts geological and geophysical studies of the Outer Continental Shelf.

The Water Resources Division studies the distribution, characteristics, and behavior of water on and under the earth's surface.

The Topographic Division maps the natural and cultural features of the land and is responsible for the National Topographic Map Series.

The Conservation Division is responsible for evaluating and supervising the development of the minerals on public lands and lately with particular emphasis on the development of the energy resources of the Outer Continental Shelf.

In the past several years we have recognized that we must do a better job of bringing our information to a clientele, new to us, of people and organizations that are involved in making decisions about the land. Therefore, we have established an Office of Land Information and Analysis to bring together the programs that cross Division boundaries. The effort of this new office will be to conduct multidisciplinary research in new methods of obtaining, interpreting, and displaying information in support of land-use decisionmaking. These studies will be aimed at a wide group of users, ranging from those having little or no training in earth sciences or geography to those conducting sophisticated analyses of the interacting processes that result in land-use patterns and changes and their relation to environmental quality. This office includes two Department of the Interior programs for which the Geological Survey is lead agency--the Resource and Land Information Program and the Earth Resources Observation Systems.

I would like to discuss now the various programs we are conducting that are most likely to be of interest to the Soil Conservation Service. Like most geologists. I'll start from the bottom and work up and remember if I say "soil" it's not the rigorous definition you're used to.

The term "soil" means many things to many people. To a farmer, perhaps it means the upper foot or so that he uses for agriculture. To a homeowner, it's the earth on which he plants his lawn and the stuff that leaks water into his basement or fails in the drainfield for his septic tank. To scientists, too, it has different meanings. A soil scientist might define soils as natural bodies of earthy materials on the earth's surface, containing living matter and capable of supporting plants out-of-doors. According to this definition the lower limit of soil would be the lower limit of biologic activity. To a geologist, however, soil commonly means all unconsolidated material above bedrock and may comprise gravel. sand, clay or organic material, or any combination of these. Both soil science and geologic study of soils yield valuable results and make complementary contributions to the resolution of environmental problems. Land-use planning, natural and man-made physical hazards. construction of highways, dams, buildings and tunnels, increased agricultural productivity, environmental pollution, and quality and availability of water are among soil-related subjects to which both sciences contribute. In addition to earth sciences generally, other scientific disciplines, aided by research in soils, include health physics, medicine, biology, archaeology, civil engineering, and other environmental sciences. Our Geologic Division presently is engaged in more than 70 projects involving aspects of soils. Survey field geologists commonly get together with soil scientists early on in their investigations to swap information. Geologic Division soil studies presently are being carried out in this country in more than 22 states from Maine to California, in urban areas and in remote regions of mountains and plains. One project studies soils adjacent to the Bering Sea. Division geologists work with soils in Iran, Alaska, Hawaii, Canada, South America, and in the Artic.

Scientists from the Survey coordinate closely with soil scientists in geochemical investigations that include environmental effects of radioactive mineral production, coal and peat mining, power plant siting, and oil field product ion. We conduct soils mechanics studies in field and laboratory that relate to geologic hazards such as slope stability, expansive soils, and liquefaction; we do research on the geochemistry of soils as a means of prospecting for mineral deposits. We study the engineering properties and even try to detect soil types from outer space.

Recently Geological Survey geologists have produced a surficial geology map of the United States under the direction of Charles B. Hunt, at a scale of 1:7,500,000 on which nine classes of unconsolidated materials are mapped and described. This is to accompany the soils map at the same scale, prepared by the SCS and published in the National Atlas. Maps showing Quaternary geology and surficial materials of the United States are presently being compiled. This work is coordinated closely with soil scientists of the Soil Conservation Service, Corps of Engineers, and other soil science groups.

Baseline geochemical data of soils are being gathered in the area of some coal-fired electric power plants in Wyoming. These data, gathered in cooperation with the Soil Conservation Service will allow monitoring of potential emission of pollutants in the areas of the plants.

Also in Wyoming's Powder River Basin, where as much as seven billion tons of coal may be recovered by strip mining, Survey geologists and Soil Conservation Service soil scientists have cooperated informally to produce pilot maps that illustrate earth science constraints to mined-land reclamation, such as post-mining terrain restoration after removing as much as 100 feet of coal, ground water supply, and variability in thickness and character of soils above the coal. A liaison between USGS and SCS will continue throughout the Basin study.

Saprolite, a residual soil weathered from complex metamorphic rocks, is being extensively studied in geologic investigations in the East. Environmental geologic studies in the Nation's Capital area have been greatly accelerated by using agricultural soils maps provided by the SCS and these cooperative studies by USGS and SCS field investigators have yielded valuable data for land-use planning.

In the West, parts of San Francisco and its surrounding urban area are huilt on detrital and residual marine and non-marine soils. This "bay mud", as it is locally called, possesses various physical properties from place to place, and these are being studied from such standpoints as stability during earthquakes, bearing strength, erodibility, and expansive soils.

A final example of Geologic Division activities is the Symposium on Geology and Food, recently convened for three days in Denver, with participation by SCS, the Agricultural Research Service, TVA, and the Department of Agronomy at Colorado State University. Subjects addressed at that symposium included the need, production, and resources of phosphate, potash, and nitrogen and nitrates; soil amendment materials; weathering of rocks, soils, trace elements, and plant nutrition; and remote sensing and computer inventory of fertilizer materials. Workshops were held on fertilizer materials, and on soil amendments and rock weathering.

At the present time, the USGS is supporting extensive research into the application of computer technology to both the treatment of soil data, and data systems oriented to earth science. One recent major development is the implementation of the Geologic Retrieval and Synopsis Program. GRASP is a portable, interactive information system independent of the data base and oriented to observational data in contrast to textual data in systems like GIPSY (General Information Processing SYstem). The public availability of GRASP allows data to reside in their home banks, thereby eliminating duplication of effort and data clutter in the banks of each individual processing center. This means that every data bank utilizing this common language will be able to share data with other authorized accessing individuals or groups. The possibilities of data exchange are, obviously, endless.

The objectives of the Geological Survey Water Resources Division are to appraise the Nation's water resources as to their quantity, quality, and availability, and to assure that adequate and accurate water information essential to the wise development and management of these resources is available.

In pursuit of its mission, the Water Resources Division has become the principal Federal water-data agency. As such, it collects and disseminates about 70 percent of all water data currently being used in the Nation. The system is supported by direct appropriations to the Survey, through cooperative programs with states and local governments, and through repay arrangements with other Federal agencies. Other data-related responsibilities of the Survey are the coordination of water data collection activities of all Federal agencies, and the design and maintenance of data-acquisition networks.

About half of the total Water Resources Division program activity involves the collection of basic data on streamflow, ground water, and quality of water, including the subsequent computations and analyses needed to present this data in usable forms. To collect such data, we operate about 18,000 surface water stations and partial record streamflow stations, and we measure water levels at about 28,000 observation wells. We determine quality of water repetively at more than 6,000 observation sites.

We conduct a wide variety of programs relating to erosion and sedimentation. The baseline data program consists of (about 1600) sediment discharge stations being operated to define the erosional characteristics before, during, and after construction of dams and highways, strip mining, and logging and other activities. We, as well as several other agencies, are trying to learn more about the transport and fate of toxic chemical constituents that sorb on sediment particles.

Movement of water in streams, lakes, bays, estuaries, aquifers, confining beds and other porous media has been described conceptually. We have simulated the movement with models (both analog and digital) whether caused by gravity, head difference, temperature, or density. We have also successfully modeled the transport of heat and certain minerals in fairly simple systems. We are working on more sophisticated models to describe and predict mass transport in water, including physical and chemical reactions within the water and/or porous media.

All land-use activities have some impact on water quantity and quality; some have great potential to degrade and reduce supply. A few examples might be: (1) waste disposal activities such as landfills, land disposal of wastewater. and waste lagoons subject to overflow, seepage, or levee destruction; (2) agricultural pollution from feedlots, pesticide application, or excess chemical fertilizers, improper construction or tilling that contribute large quantities of sediment; and (3) urban developments that cause flash runoff and erosion, spread highway chemicals, and pave recharge areas.

Most of you are probably familiar with our technical reports--Water-Supply Papers, Geologic Bulletins, Circulars, and Professional Papers, but we also release our water data through the publication series of many of our cooperators at the State and local levels. Streamflow, water quality, and ground water level data are published in informal annual data releases according to State boundaries. The releases are available from either the headquarters office or the appropriate district office.

Most of our data are available in machine-readable form. We use computers to process digitally recorded field data and to store and retrieve data in the Survey's information system. About 275,000 station years of streamflow data and a volume of information equivalent to about 100,000 station years for some 50,000 wells and 5,000 water quality stations are available. The current streamflow and water quality records are stored in the central file on magnetic disks whereas the historic data are available on magnetic tape.

Almost all the streamflow data placed in the permanent magnetic tape file of daily discharges is subjected to a package of three magnitude-frequency analyses.

A large number of other analyses currently are being made on selected daily discharge using the computer. These include several types of probability analyses, low flow recession analyses, flow variability studies, backwater analyses, analyses of the effect of physical characteristics of river basins on flow, analyses on the interrelationships of surface waters and ground waters, and many others.

Our water activities are reported in some 800 published products a year and produce a growth in our data files of about 10 percent per year. Others in the water resources field, I'm sure, experience similar rates of expansion in information activities. However, because of the massive amounts of information available, those working in the field of water information have had to face a double-barreled problem: not only is more information available, but the demand for quicker, more reliable information and in a" easily digested format has mushroomed with the environmental movement.

People, especially nontechnical people, are more aware of the water environment, more concerned with their water resource, and want to know more about the health and status of those resources; and they want to know now, in language they can understand.

As previously noted, a principal program of the Water Resources Division involves' the coordination of Federal water data acquisition activities. Several of these activities involve both the water resources and soil sciences communities and result in improved communication and coordination among these two groups. Let me cite five examples.

First, we have underway a procedure for carrying out coordination of water data acquisition activities through field offices of the Geological Survey and other Federal agencies, including SCS. The mechanism works this way. Using the information about ongoing water-data activities, that is put in the Catalog of Information on Water Data, agencies are asked to identify any new activities they plan to conduct which will produce water data, and to identify beyond this their needs for information that are not now being met by the various programs that are producing water information. This input is consolidated in the form of regional plans for each of the 21 major water resources regions and these in turn become available and are used in producing an annual plan to the Office of Management and Budget. The intent of the activity is to look ahead and identify emerging needs for information and then to do collectively as much as possible to coordinate ongoing and planned activities in order to better meet these needs. The Soil Conservation Service, through its field organization, is actively participating in this field coordination activity.

A second area in which significant progress is being made concerns the development of recommended methods for the acquisition of water data. We are just entering into the second expanded phase of this activity which will go beyond the traditional forms of water data such as streamflow measurements and water quality determinations into other areas such as soil moisture and basin characteristics. This is an interagency effort that involves the non-Federal as well as the Federal water resources community and will involve the Soil Conservation Service to a great extent in the working groups that are being established to consider the methods for obtaining information on drainage basin characteristics, on soil moisture, and on snow and ice.

A third area that is aimed at improving coordination and communication among agencies is the development of a new series of basic hydrologic unit maps together with codes for some 1500 drainage basins across the country. This new map series on the State base maps at a scale of 1:500,000 will provide, for the first time on an adequate base, a nationally consistent set of basins across the country. In developing these maps, the drainage basin boundaries that had been developed by the Soil Conservation Service several years back were used extensively, and the Soil Conservation Service has been actively involved in the review and approval of these basin boundaries on the new maps. We feel that, through this mechanism, we shall have achieved a common set of boundaries that can be used by all parties concerned with water and related land information and that the communications among groups will be greatly enhanced by the use of these common boundaries. These same boundaries will also be portrayed on the new series of land-use maps being prepared by the Geological Survey at a scale of 1:250,000.

A fourth area where the agencies have been cooperating closely in the field of water information concerns the needs for water data as they relate to small watersheds. A report has just been completed that summarizes a rather detailed interagency study of the requirements and the needs for this type of information. As this relates directly to the mission of the Soil Conservation Service and other agencies concerned with management of land resources, this report should receive rather widespread use among these agencies. In essence it identifies a deficiency of information and calls for the establishment of a coordinated network of stream gaging and precipitation measuring stations in many areas of the country.

Finally, we are cooperating closely with other agencies, both Federal and non-Federal, to identify, by means of a Catalog of Information on Water Data, just what kinds of data are being collected where and at what frequency. This catalog has proved useful to the entire water and related land resources community by serving as a means of identifying where data can be located for the potential data user. It is the forerunner to a much broader improvement of handling of water data that will be on-line later this year in the form of NAWDEX, the National Water Data Exchange. When fully operational, this system (NAWDEX) will link together the various data banks concerned with water and will provide a means whereby the organization that needs water information can identify what is available and can acquire these data together with Information about how the data were collected; researchers may then evaluate the adequacy of the data for their own particular purposes.

The activities just discussed exemplify the coordination that is ongoing with the Geological Survey as lead agency but with full participation of other agencies, including the Soil Conservation Service. The goal, of course, is to improve the data base in the field of water resources and to provide ready accessibility of data to the user.

Interagency cooperation is evident in flood investigations. The preparation of maps delineating areas of flood potential is one outstanding example.

In 1969, the Geological Survey started a project of quickly informing individuals and communities about areas of flood potential. The work began in response to a recommendation of the Task Force on Federal Flood Control Policy described in House Document 465 of the 89th Congress. The project delineated on maps the approximate boundaries of areas occasionally flooded, but with no reference to the magnitude or frequency of the depicted flood. A primary objective was to produce the flood maps quickly from available photographs, maps, historic flood data and stream gaging records. Soil survey maps proved a valuable aid in the delineations.

The flood-mapping work was altered slightly in 1970 to show approximate boundaries of a "100-year" rather than an "occasional" flood. Again, the boundaries were defined only to a reconnaissance level of accuracy from readily available data. This change was requested by the Federal Insurance Administration (HUD) to allow use of the maps in managing the National Flood Insurance Program. The maps proved to be so useful that FIA financed an acceleration of map production. The Soil Conservation Service and the Tennessee Valley Authority joined the Geological Survey in producing these maps during 1972-73 to aid in getting needed coverage of the developed and developing areas of the Nation.

To date, approximate flood boundaries have been delineated on nearly 12,000 quadrangle maps. The SCS effort produced 417 maps in 21 states. Flood-prone areas have been delineated on about 95 percent of the 9,000 topographic maps of developed and developing areas where the information is most needed. The Geological Survey is continuing to produce the flood maps for areas having a known flood problem, for areas of potential future development, for areas in the public domain where management decisions may be needed, and for recreational areas. It is expected that a total of 15,000 maps covering about half the Nation may be prepared.

Copies of the "Flood-Prone Area" maps produced by the Geological Survey may be obtained free from district offices of the Survey. Headquarters officials of the Survey and SCS recently completed arrangements for the USGS to print, stock, and distribute flood maps produced by the SCS.

In the past several years, there has been special interest for more coordination between the SCS and the USGS in the field of utilization of Topographic Division products. The USGS orthophotoquad is being utilized by SCS as the photoimage map base for publishing soils data. Additionally, the Survey's adoption of an intermediate-scale series (mapping between 1:24,000 and 1:250,000 scale) should become a useful base map for meeting SCS needs for special areas, counties, or regions.

The new Survey orthophotoquad program began this fiscal year with a plan for preparing 5,000 7.5-minute quadrangles by July 1, 1975. An index map is available showing the availability of orthophotos for the U. S. The SCS is the leading agency in cooperating with the USGS in producing orthophotoquads by actively cost sharing in about 50 areas covering approximately 1,700 7.5-minute quadrangles. The Survey's goal, within the next three years, is to provide 7.5-minute orthophotoquad coverage of all areas of the U. S. not yet mapped in the 7.5-minute topographic series.

The national requirement for standard base intermediate-scale maps is fully recognized as a" area where the USGS can be of assistance. County format and quadrangle format mapping at 1:50,000 and 1:100,000 is under-way in several states. The SCS has recently conferred with the USGS regarding requirements for U. S. wide map coverage at 1:100,000 scale. Funding for such a program needs to be determined.

Other activities where the USGS can assist in responding to current mapping needs are slope mapping and furnishing map data in digital form. Slope maps for soil studies can be produced at relatively low cost from existing contour data. Digitizing base map categories such as terrain. drainage, land net, civil boundaries, and transportation routes is another area where we are tooling-up to meet urgent requirements from a number of Federal agencies including SCS. USGS is digitizing these map categories at 1:24,000 scale for coal resource studies in Jewel1 Ridge, Virginia. Digital terrain data at 1:250,000 scale compiled by the Defense Mapping Agency are now available from the Geological Survey.

Another area of interest to the Federal and State governments concerns the management of coastal zones. New legislation has been enacted which will require well defined objectives for use of the land. Coastal zone mapping will need to be updated to better define these zones. Workshops have been held to reach accord on requirements for coastal zone mapping. As a result a Coastal Zone Mapping Handbook is being prepared jointly by the National Ocean Survey and USGS. Another mapping tool, the orthophoto-map, which combines a line map with photographic imagery is available for several areas where water features are predominant. The Survey is researching new ways of combining the image map with the line map during standard revision operations.

The past year a National Cartographic Information Center was organized, staffed, and became operational to help provide information for map users. This organization has become a focal point for information of all U. S. cartographic data including aerial and space imagery, maps and charts, and geodetic control. In addition, better knowledge of other agency holdings and data acquisition plans will be available to users. A more efficient mechanism for ordering data has been developed, resulting in better service to both government and public organizations. To become even more effective NCIC is encouraging interagency agreements for participation. As you may know, preliminary meetings were held with SCS on December 17 to develop summary records of the aerial photography holdings of your agency. An amendment to the current SCS-USGS mapping agreement is now being drafted in anticipation that preliminary work will start on the aerial photography summary records in the next month.

I would like to move now to a discussion of the programs of the Office of Land Information and Analysis. This is the new office that I mentioned earlier that we have organized to bring together programs that cross Geological Survey Division boundaries. Its main thrust is to make our earth science products more useful and in the long run to bridge the gap between physical science and social science. This is, of course. the new definition of "Geography" and I suspect that if and when this new office develops fully, it may be designated as the "Geographic Division." Appropriately, the new office includes a Geography Program under Jim Anderson, our Chief Geographer, who will be with you during your whole conference. It also includes two Department of the Interior programs. the Earth Resources Observation System and the Resource and Land Information Program. An Earth Sciences Applications Program and an Environmental Impact Analysis Program completes the ensemble.

The U. S. Geological Survey is initiating. as part of its Geography Program, a Land Use Data and Analysis (LUDA) Program during the Fiscal Year 1975. This program will provide a systematic and comprehensive collection and analysis of current land-use and land cover data (derived from remotely sensed source material) on a regional scale of 1:250,000. The maps will show the 38 Level II land-use categories described in USGS Circular 671 that is currently being revised with input from SCS and other Federal and State organizations. The program is designed to supply these data for the entire country within a 5-year period and to provide for the periodic revision of the data. Because of the dynamics of land use, the emphasis in the preparation and distribution of all products will be on supplying the information to users in the shortest possible time. Applied research in data and information requirements, inventory methods, and data use, as well as interpretative studies will also be carried out under the program in order to assist in supplying needed current land-use and land cover data for planning, resource management, and other purposes.

Selected experimental demonstration land-use and cover maps at 1:24,000 or 1:50,000 scale will also be prepared. These will show how land-use and cover mapping at a regional scale, such as the 1:250,000 LUDA maps, can be related to more detailed maps.

As early as 1970, personnel from the Soil Conservation Service had contributed significantly to the development of a meaningful framework for the classification of land-use and land cover on a nationwide basis. Bill Johnson and Jerry Gockowski were members of an interagency committee which studied the maximum use of potential of remote sensor data, chiefly from high altitude aircraft and ERTS, obtaining current land use and land cover data.

Land use and land cover mapping is now nearly completed for 25 1:250,000 topographic sheets which serve as the mapping base. Approximately 200,000 square miles have already been mapped under pre-LUDA programs, primarily in the States of Arizona, Maryland, Delaware, Virginia, Pennsylvania, Missouri, Arkansas, Louisiana, Oklahoma and Kansas. Land use and land cover mapping is in progress for an additional 65 sheets, totaling about 500,000 square miles, in FY 75. Mapping is completed for Maryland, Delaware, Arkansas, and Louisiana, and cooperative agreements exist for mapping all of Kansas, Florida. and Pennsylvania within the next year. Coastal areas adjacent to probable offshore oil exploration and drilling areas are receiving particular attention in FY 75. Recommendations from SCS for future priorities in mapping are invited.

With the operational LUDA Program now well underway, our Geography Program is extending the research and development activities which helped to bring it into being. Activities include urban climatology, multidisciplinary environmental studies, comparative urban land use studies, and state-of-the-art work in use of sensors aboard aircraft and satellite. One activity showing promise is the use of computer manipulation of multitemporal and multispectral satellite data in its original digital format. While our initial concern has been the mapping of land cover and land cover change, we are aware of wider application of the techniques. Besides uses in surface geology and hydrology, uses in wetland and vegetation mapping are also apparent. The seasonal “looks” afforded by satellite observation are making possible the identification of crops and their vigor, progress of logging and strip mining operations, extent of seasonally bare soils, and discrimination of pastureland from cropland.

Among the advantages of semi-automated classification are the relative speed at which it can produce fine detail over large areas, the ability to supply comprehensive area coverage at different seasons, and the ease with which data can be manipulated from digital format. This activity has had significant support from the EROS Program which is the principal Interior Department activity seeking sways to use remote sensing data acquired from aircraft and spacecraft. The EROS Program is designed to contribute to many of the data-gathering requirements in the Department--Bureau of Land Management. Bureau of Reclamation, Fish and Wildlife Service, etc. EROS is a Departmental program administered by the Geological Survey as lead agency.

In 1966, the Interior Department, through the EROS Program, sent to NASA the general operational requirements for the first experimental earth resources satellite. That satellite, initially known as ERTS, was launched in 1972 and has been providing multispectral imagery in the visible and near infrared to earth scientists, resource planners and agricultural users throughout the world ever since. Al though ERTS-1 is an experimental satellite, it has worked extremely well.

The second satellite in this series, now renamed LANDSAT-2, was launched last Wednesday, and initial reports indicate that the orbital configurations and system performance are outstanding.

The sale of multispectral imagery from these satellites to the public. both domestic and foreign, is achieved jointly by the EROS Data Center at Sioux Falls, South Dakota; NOAA in Suitland, Maryland; and the Department of Agriculture's photographic laboratory in Salt Lake City. The EROS Data Center's data base includes more than a half million items of ERTS data, plus more than five million frames of NASA, USGS, and Corps of Engineers' aerial photography.

In addition to public sales of satellite and aircraft imagery, the EROS Program offers training in the form of classroom lectures. laboratory experiments, and field exercises in remote sensing for groups of resource managers and scientists, not only from the Department of the Interior, but other Federal departments, as well ss foreign participants under the sponsorship of AID. This training is offered at the EROS Data Center, as well as at EROS Application Assistance Facilities located at Bay St. Louis, Mississippi; Phoenix, Arizona; Menlo Park, California; Denver, Colorado; Reston, Virginia; and the Canal zone. Perhaps of interest to this audience is a workshop for Department of Agriculture's Statistical Reporting Service personnel from the northcentral states which is scheduled for early April 1975 at the EROS Data Center. Another workshop with Soil Conservation Service personnel from the northcentral states is tentatively scheduled for early FY 1976.

In collaboration with other Bureaus in the Department of the Interior, the EROS Program also conducts projects to demonstrate potential applications of remote sensing to operational activities of the Bureaus. For example, the EROS Program is cooperating with the Bureau of Reclamation in a test of a network of on-the-ground precipitation sensors near Miles City, Montana, which transmit via LANDSAT to a central facility of Reclamation. The objective of the experiment is to augment operation of a large-scale cloud seeding experiment. The EROS Program and the Fish and Wildlife Service are cooperatively supporting an effort to demonstrate the utility of LANDSAT imagery to measure seasonal change in the areal extent of surface water in migratory bird flyways, correlating these observations with ground surveys, therein improving prediction of waterfowl production. EROS and University of Nebraska scientists are using LANDSAT imagery to systematically monitor the increased deployment of center pivot irrigation systems in Holt County, Nebraska. In part of Holt County, for example. center pivot installations have increased from 508 in 1972, to 552 in 1973, to 740 in 1974; continued increase could affect the local water table in some areas.

The Soil Conservation Service has produced LANDSAT image mosaics of the entire conterminous United States and Alaska at scales of 1:1,000,000 and 1:5,000,000. The EROS Program is collaborating with the Service in producing lithographic copies of the 1:5,000,000 mosaic, which will be available in March 1975 through both DOA and DOI/USGS distribution centers at $1.25 pet copy.

Another example of SCS/USGS cooperation-relates to the fact that both of our Bureaus are nurturing fledgling programs designed to provide a more adequate information and knowledge base to support land-use analysis. Your program is titled the Land Inventory and Monitoring (LIM) Program, and ours is the Resource and Land Information (RALI) Program.

For over a year a representative from our RALI Program has, at your formal invitation, been attending and observing LIM advisory committee meetings at both the SCS Bureau and Agriculture Department levels. It has been a rewarding experience for us to participate in the difficult task of defining LIM Program goals, objectives, and priorities.

A few months ago, the RALI Program was able to reciprocate by making SCS an ex-officio member of its Departmental Coordinating Committee. We expect this relationship to be equally fruitful, and have already prevailed on the LIM attendees to comment and advise RALI on several proposed and ongoing projects relating to the display of natural resources data, in map form, for basically non-technical audiences--principally land resource managers.

Like the LIM Program, the RALI Program has been endorsed "in principle" but has failed to obtain adequate financial support up the line. However, we have been able to accomplish some limited objectives. We have demonstrated the use of existing data to prepare thematic maps for three areas. Phoenix-Tucson, Powder River Basin, and Puget Sound. We have prepared a multidisciplinary report on South Dade County, Florida. and are in the process of publishing one on the environment of South Florida. All of the activities have involved other Interior Bureaus, and the SCS has provided input to both the Phoenix-Tucson and Powder River projects.

I have brought along a few copies of the RALI sponsored products to give you an idea of the direction in which we are heading. I also have brought along copies of a list of available and planned products. These include contract studies by MITRE and by the Council of State Governments relating to data and information needs and availability, and methodological guidebooks being prepared under the lead agency concept.

The guidebooks involve the development of guidelines for the selection of critical environmental areas, assessment of State land inventory and data handling needs, evaluation of the environmental impact of pipeline and transmission line corridors, and identification of potential environmental impact of a wide variety of activities. Preparation of the first two guidebooks is the responsibility of the Office of Land Use and Water Planning, the third is the responsibility of the Bureau of Land Management, and the last is the responsibility of the Geological Survey.

Because we are trying to find ways to present technical natural resources information in a form meaningful to planners and managers, particularly at the State and local level, we have great expectations regarding the value of the grants we have made to the Council of State Governments. The first grant will result in a series of reports recounting the needs of States for environmental information. The second will provide an evaluation of the utility of map products--both traditional and experimental--to planners and managers.

Moat of these projects are scheduled for completion by the end of this fiscal year or early in FY 1976. Following a period of assimilation and evaluation, we expect to have a much better understanding of the needs of decisionmakers for natural resources data and how best to meet them.

In part to support the Departmental RALI Program and in part to more effectively meet Geological Survey mission responsibilities, we have established the Earth Sciences Applications Program to coordinate and integrate the core disciplines of the Geological Survey--the geographic, hydrologic, geologic, and cartographic sciences. This program provides highly innovative multidisciplinary earth science products in clear and understandable language and formats designed to facilitate problem solving by providing insight into the environmental consequences of alternative land-use decisions.

Studies are being made in representative urban and rural parts of the Nation selected so that the products and technologies developed in these areas will have broad national transfer value. In addition, intensive user interaction at all stages of the studies characterize the program to assure maximum utility of the resulting products.

The San Francisco Bay Regional Study, which began in 1970 and which is scheduled to be completed in 1976, represents the most intensive effort to date in the Earth Sciences Applications Program. Thus far, more than 80 reports have been released as a result of this study. In addit ion, twelve summary multidisciplinary interpretive reports, considering such subjects as flood inundation, erosion and sedimentation, slope stability, and seismic hazards, are nearing completion. These will summarize the scientific results of the study and will focus on their land-use planning implications, with particular emphasis on regional planning.

Similar studies are being conducted in six other urban-centered parts of the country--Puget Sound, Phoenix-Tucson, Denver, Pittsburgh, Baltimore-Washington, and the Connecticut Valley. These studies, too, have been oriented toward the development of products needed to support land-use decisionmaking. I" overall aspect, the seven urban-centered studies have been highly productive in terms of stimulating the use of earth science information in planning, including the enactment of legislation.

Finally, the Earth Sciences Applications Program presently is coordinating multidivision inputs to the Water Resources Division's "Intensive River Quality Assessments." In FY 1975, one such assessment is scheduled to be initiated for the Chattahoochee River Basin in Georgia and Alabama, and another is planned for the Yampa River Basin in western Colorado. The Chattahoochee Study will provide a" opportunity to evaluate point and non-point sources of pollution in a highly developed river basin, and the Yampa Basin will provide the opportunity to study changes in water quality associated with intensive development of coal and oil-shale deposits. It is apparent that both studies require the full spectrum of Geological Survey scientific expertise, and it is the mission of the Earth Sciences Applications Program to marshal1 that expertise.

Last, but not least, I'd like to discuss a" activity in which all Federal agencies participate--that of responding to the National Environmental Protection Act. This activity, like the other units of our new office, requires a multidisciplinary approach.

We have, therefore, established the new Environmental Impact Analysis Program to provide direction, coordination, and technical expertise in the preparation of Environmental Impact Statements for which the Geological Survey is lead or joint agency. The program also will provide technical analysis and review of Environmental Impact Statements prepared by other agencies. This responsibility to prepare or review a large number of EIS provides the Environmental Impact Analysis Program with a" unusual opportunity to pursue research in environmental impact studies.

We will review, record, and analyze the needs, problems, and assistance required by many organizations that prepare impact statements. Ancilliary research will establish the methods by which the Geological Survey can best assist these organizations within the scope of our expertise. In the preparation of our EIS, we will develop guidelines and manuals for the logical presentation of USGS information in a format that satisfies NEPA requirements.

From selected EIS case histories, we will analyze the actual and potential impacts of various actions reported in Environmental Impact Statements and assess these, especially in terms of land-use decisionmaking. we will stimulate, perform, and supervise topical investigations and research needed to formulate and implement Survey and Interior policy, particularly with respect to the preparation of impact statements, and recommend research programs to be initiated by the Survey. We intend to design and supervise research programs concerned with the thresholds at which Environmental Impact Statements should be required, and which aspects are critical.

I have gone on at great length, but both our organizations are large, and the problems we must face jointly are larger. I have tried to identify the areas of our mutual interest and the services and expertise that the Geological Survey can supply to the Soil Conservation Service. We feel very strongly that we are now fully committed to applying our scientific resources to the sobering problems of the 70's. The natural scientists in both our organizations have a keen appreciation of the great value and beauty of the laboratory in which we work. The choices between needs and aesthetics will be difficult. but if we do not assist in these choices then we will have failed our most important and ultimate test.

Thank you for the opportunity to present to you the Survey activities that seam to us to be of interest to both our organizations. We will continue to cooperate at field and headquarter levels, and if there are further ways that we can help you, please do not hesitate to communicate with us at the National Center, Reston, Virginia.

Northeast Region Report

R. V. Rourke*

It is a pleasure to be here today to renew old acquaintances and to meet with men interested In soils and soil surveys from other regions and countries.

Today I shall review the committee reports of the 1974 Northeast Conference. The conference was informative and generated considerable constructive comment from those in attendance. A complete review of each committee report is available in the conference proceedings thus I will summarize the reports to meet the time requirements of this conference.

The conference was opened by Mr. William Johnson, who spoke on the subject of "Soil Survey Objectives". His presentation was followed by an address by Dr. L. J. Bartelli concerning the "Modern Thrust in Soil Survey Interpretations". Both subjects are basic to the intensive use to which much of the land In the Northeast is being subjected. Later, reports were given by representatives of the varlous experiment stations concerning their activities as they pertained to soils and soil surveys.

The committee concerned with the legal aspects of the use and interpretation of soil surveys filed an extensive review of the legislation and other documents pertaining to soil surveys in the Northeast and in the rest of the country. At the time of the conference, Maine and North Dakota had registration programs for soil scientists. The committee recommended that common terminology be developed for state ordinances. It further presented the request that a model ordinance be developed.

The committee that worked with the problem of using soils for waste disposal felt that guidelines might be established by 1975 that would reflect soils as a method of disposing of wastes from: animals, septic effluent, sewage treatment plant effluent, sewage sludge, and sanitary landfill. Constructive suggestions were offered to improve the "Guide for Rating Limitations of Soils for Disposal of Waste". A review of research needs in area of waste disposal and a list of recent publications pertaining to waste disposal in soils was presented.

The recommendations of the committee reviewing the establishment of guidelines for overcoming limitations Of soils for different uses indicated a need to present these methods particularly in the non-farm area. It was suggested that a county soil survey be developed in the Northeast, on

*Department of Plant and Soil Science, University of Maine, Orono, Maine.

a trial basis, in which the format of overcoming soil limitations for non-farm uses be attempted.

The soil survey interpretations committee dealt with the section of potential frost heaving in the "Guide for Interpreting Engineering Uses of Soils". It was decided that the 250 degree day line should extend along the southern New England coast and across Cape Cod in a manner that Long Island, N.Y. was south of the line. The potential frost action interpretations should be separate for soils in the frigid and mesic zones. No frost action ratings should be made as criteria in judging material for road fill. The particle size class having the greatest frost hazard should be used when contrasting textures are evaluated for frost action. In other activities the committee suggested that guidelines for new interpretations should begin at the state level and be correlated regionally. If adopted nationally, they should become a part of the soil interpretation handbook. It was proposed that in the area of septic waste disposal new criteria be applied for depth to water table because of the conflict resulting from water table depths in well drained soils in the Northeast.

The soil moisture regimes committee proposed that a water table study be initiated to monitor water movement In a sequence of soils on the landscape. They felt that the depth and duration of the water table should be expressed graphically on a yearly basis. It was hoped that a regional project would be developed and initiated amongst the various research agencies concerning water tables. A bibliography of water table studies was included in the report.

A review of the classification of disturbed soils was done and several proposals were made. A proposal by W. Virginia was most detailed and inlcuded various subdivisions to be established within a new suborder of Entisols termed Spolents. A review of several profile descriptions of disturbed soils was presented jointly by Univ. of Md., S.C.S., Univ. of Pa. and the National Park Service.

The committee active in the area of criteria for classifying families and series recommended several areas that should be Investigated: moderately deep soils, modifiers of the series level other than soil properties, format changes of official series descriptions, and the need to determine the effect of sands being included In the camblc definition. They proposed that color ranges continue to be reported as ranges of hue, value, and chroma. It was felt that a need exists to develop areas of special interests ie., "fragipans In the Northeast". A lively and informative evening session was held concerning fraglpan concepts in the Northeast,

The group dealing with organic soils and tidal marsh concluded that It is not possible to use plant species as an Indicator of tidal marsh properties other than for salinity. The methods and other techniques used in New Hampshire's study of tidal marsh soils were presented. The committee Indicated that mapping units based upon subgroups or phases of subgroups were adequate.

In the Northeast the committee dealing with soil research needs felt that the most pressing areas are those In the soil water, environmental, and other non-agricultural subjects. They intend to develop an inventory of published and unpublished benchmark soil data in the Northeast.

The forest soils committee explored the types of soil surveys being done by U.S. Forest Service In various regions of the country. The committee stressed that the users needs should be considered when the legend was developed. It was their hope that all extensive soil surveys be in a form that would permit national correlation.

The remote sensing committee was somewhat Inhibited by the lack of people presently utilizing this technique in the Northeast.

In closing I wish to comment that the biannual regional meetings are most beneficial. This is the only time that people throughout the Northeast, who are interested in soil survey and soil survey investigations, meet to constructively review soil survey problems. The meetings are well attended and the discussion evolved is lively. The meetings serve as an excellent method of presenting and reviewing soils and soil survey problems as they relate to Intensive soil use.

REPORT OF THE LAND GRANT COLLEGE REPRESENTATIVE OF THE SOUTHERN REGION

H. B. Vanderford*

The biennial Southern Regional Technical Work-Planning Conference of the Cooperative Soil Survey met at Mobile, Alabama on March 11-15, 1974, with Dr. B. F. Hajek, Chairman (Auburn University) and E. A. Perry, Vice Chairman (USDA-SCS).

The members welcomed and appreciated the participation of the following speakers who were invited to address the conference:

Major Greenough, City of Mobile.
W. B. Lingle, State Conservationist, SCS, Auburn, Alabama.
Dr. R. D. Rouse, Dean and Director, School of Agriculture and Agricultural Experiment Station, Auburn University.
Dr. C. S. Hoveland, Professor, Agronomy and Soils Department, Auburn Universitv.
Dr. Warren McCord, Alabama Cooperative Extension Service, Auburn, Alabama.
Dr. John E. McClelland, Director, Soil Survey Operations, SCS, Washington, D.C.

About 68 individuals participated in the Conference, representing 14 universities and experiment stations, the Soil Conservation Service, Agricultural Research Service, and U. S. Forest Service.

The main work of the conference was performed by the action of eight committees. Each committee prepared and presented a report and all of these reports were published and are available to the members of this National Conference. Consequently, I will not give a summary of each committee report.

An Ad Hoc Committee reported on the status of and interest in the certification of professional soil classifiers in the southern states. There is much interest in such an organization although the extent of the interest and progress made varies from state to state. South Carolina has passed a certification law, and Tennessee has introduced a law in the state legislature. A bill is being considered in the Mississippi legislature now. Several other states are in the process of organizing state groups which will prepare and introduce laws later.

---

* State Soil Survey Leader, Agronomy Department, Mississippi State University, Mississippi State, Mississippi 39762.

The Southern Soil Survey Work Group has had a project involving the preparation and publication of a general soil map of the South and Puerto Rico for the past few years. This project has been under the leadership of Dr. Stan Buol of North Carolina State University. The maps have been released and distributed along with bulletins giving valuable information and interpretations. This document is entitled "Southern Cooperative Series Bulletin No. 174."

The contributions of the Land Grant Institutions in the South to the Cooperative Soil Survey Program is a perennial topic of discussion. This situation has improved some recently. The Florida legislature appropriated over one half million dollars for soil survey in 1974. Virginia and North Carolina are also spending large amounts of state funds for soil survey activities. Several other states will likely be able to use more state funds to support the soil survey program in the future.

After the committee report on "Automatic Data Processing" considerable discussion was directed to methods which would decrease the time period from field mapping to the release and distribution of survey data to users. It was pointed out that computer technology has great potential in saving time in the preparation of manuscripts and reviews of same. Modular writing lends itself well to computer storage and retrieval. New applications of computer technology will likely become useful in soil survey operations in the future.

In addition to the regular conference Messrs. Grant Mattox, Party Leader; Earl Norton, District Conservationist; and Charles Owens, Soil Scientist, organized and conducted a soil study tour of the Mobile area. This provided an opportunity for the group to study several soil profiles and obtain interpretative information. The tour was a valuable contribution to the Conference.

REPORT FROM NORTH-CENTRAL REGION LAND-GRANT UNIVERSITIES

T. E. Fenton[1]

The technical committee concerned with soil survey in the North-Central Region is NCR-3. This committee has the responsibility of coordinating the university efforts concerning soil survey in the region. Each university and several federal agencies have representatives on this committee, Hollis Omodt from North Dakota was the other university representative from the North-Central Region scheduled to attend this conference. However, Hollis could not attend due to the illness of his wife.

A funded research project, NC-109, began in 1972 and was approved through 1976. The project is entitled "Soil Landscape Characteristics Affecting Land-Use Planning and Rural Development." Two general objectives of the project are a) to define, map, and evaluate soil landscape units in terms of alternative land uses in rural and suburban areas; b) to develop and publish soil landscape guides for land-use planning and rural development. There is a range of projects in various states within the region that are working toward some area of the objectives listed above.

Subcommittees of NCR-3 and NC-109 are presently involved in the following areas: a) development of criteria for prime agricultural land in the Midwest so that a map of the region, using the units shown in NCR Publication 76, can be published; b) investigation of format and content of soil survey reports; c) soil taxonomy; d) interstate correlation of laboratory analyses.

The Regional Technical Work-Planning Conference was held at Osage Beach, Missouri, April 8-12, 1974. Several Extension people attended the meeting, Bill Oschwald, Extension Agronomist, University of Illinois, and Harry Galloway, Extension Agronomist, Purdue, presented thought-provoking ideas concerning communication aspects of soil survey information programs, including an analysis of the present format of soil survey reports.

The theme of the regional workshop centered on interpretations. I would like to briefly outline some of the concerns in our region that were expressed at that meeting and subsequent to that meeting.

I believe we can all agree that the basis of our activities in the National Cooperative Soil Survey is the soil map. The kind of map produced depends on several factors including, among others, map scale, detail shown on the map, mapping unit design, and field procedures. The degree of refinement can be adjusted by the legend used in each survey area. This means that the mapping unit definition and composition are critical to use and interpretation of the soil map. Combination of soil mapping units subsequent

[1]/Department of Agronomy, Iowa State University, Ames, Iowa.

to completion of mapping is generally not desirable. Field decisions and resulting boundaries in most cases would change. Therefore, our workshop encouraged all concerned individuals to participate in the initial field review and in setting up of the legend.

Soil science has progressed greatly in the past few years, and much quantitative data is available. However, on a day-to-day basis in soil survey, we still make many judgments and decisions which are not based on quantitative data but upon our knowledge and experience with the soils. For example, many factors affecting use and management can not be easily expressed in quantitative terms but are apparent when viewed in the field.

Increased interest, together with increased support from nonfederal sources, has greatly accelerated soil survey programs in many states. This increased support has come about for various reasons. The needs and goals of individual states and of survey areas within a state are not necessarily uniform. However, I believe we all have a common goal--the production of the best possible soil survey with the resources available.

Those of us at the state level (both state and federal employees) who work on a day-to-day basis with our users are in the best position to recognize the needs of our individual state and survey area. In my judgment the National Cooperative Soil Survey should become more sensitive to the individual needs and desires of the states. I would like to raise a series of questions based on my experience in the past few months to illustrate my point.

1. Is it reasonable to expect individual states to alter and readjust their programs on short notice because of a national or regional memo, advisory, or directive? A recent regional advisory indicated all text manuscripts for surveys scheduled to be sent to the printer in F.Y. 1978 must be written according to a new procedure. Any mapping unit already written will be rewritten following the new format. Are directives such as these in the spirit of a cooperative soil survey? Is this policy the best use of the limited resources we have to work with? Is it not a waste of our soil scientists' time and talents to rewrite these mapping units?

2. Is it reasonable to have a policy that encourages more detailed and specific interpretations of pedons and at the same time encourages fewer soil mapping units, broader ranges of properties within units, and deemphasizes the importance of landscape parameters?

3. Is the Cooperative Soil Survey sensitive to the needs of the user? Does the changing of long-used, well-accepted terms, for example, Marsh to "Fluvaquents, wet", contribute to a better understanding by our users of the soils of the survey area? I have attended many meetings with users in our state, and our basic units of communication are the soil series, the soil types, and the soil phases, not higher categories of the classification system.

4. Should not the guidelines used in preparation of handbooks and(or) manuscripts also provide for the information needed to adequately justify the correlation of mapping units?

5. How can national and regional memos, directives, etc. be more efficiently integrated into state programs? Is it reasonable to expect that specific guidelines, rules, and (or) regulations written at the regional and national levels will best serve the needs of all states and all survey areas in the United States?

In any organization or group there is a need for some basic rules. However, the question I raise is this: "What types of guidelines and regulations best serve the overall interests of the National Cooperative Soil Survey Program?" I suggest that the optimum program is a) based on broad, general guidelines at the regional and national levels that allow the states maximum flexibility in utilization of their resources in developing soil surveys that truly meet their needs and the needs of their users; and b) is truly cooperative.

One final item of business from the North-Central Region: Don Franzmeier, who is editor of Soil Survey Horizons, a soil survey publication normally circulated mainly in the North-Central Region, asked me to relay to you that Soil Survey Horizons in the future will be printed, distributed, and subscribed to from the Soil Science Society of America. However, the present Soil Survey Horizons publication corporation will continue to be the publishers. We hope that all of you will contribute to and support this publication which is designed primarily for those of us in the field of Soil Genesis and Classification.

REPORT FROM WESTERN REGION
LAND GRANT UNIVERSITIES

G. A. Nielsen*

It is a pleasure for me to participate in this National Soil Survey Conference and to represent the Western Agricultural Experiment Stations along with Bob Hell of Colorado.

The Western Technical Work-planning Conference met last January in San Diego. The proceedings are published. Reports from 7 of the technical committees have provided input for national committee reports to be reviewed this week in Orlando and will not be summarized here. Rather, your attention is drawn to three regional efforts which will not receive our formal consideration.

The Committee on Soil Taxonomy reported that soil moisture regimes are adequately defined in Soil Taxonomy and that there are no problems in their use. There was concern however, that a shortage of data has made it necessary to draw arbitary boundaries that are difficult to defend. The Committee recommended a redefinition of soil; clarification of criteria for several subgroups of Histosols, Andepts, Aquods and Boralfs; and clarification regarding Vertisols vs. vertic subgroups in frigid and cryic temperature regimes, Lithic Vertisols, and O-horizon requirements in cryic temperature regimes.

The Committee on Improving Soil Survey Interpretations proposed 10 revised guide sheets for engineering uses of soils. They also recommended a general format for information on overcoming soil limitations, these to be compiled in SCS field offices in cooperation with sanitarians, contractors and others.

The Committee on Description of Internal Properties of Soils reviewed the particle size classes in a draft of the Soil Survey Manual. They recommend the .074 mm boundary between sand and silt and prefer to leave the boundary at .05 rather than change to .0625 mm proposed by the Soil Science Society. This committee also reviewed consistence terms in the draft manual, pointing out that the terms and tests have not been widely circulated. Consequently, field testing has been vary limited and ability of field men to apply the tests is not known.

The regional meeting in San Diego provided an opportunity to review a unique and innovative soil survey. The San Diego county survey was reported in two volumes, Volume I-Soil Facts and Volume II-Soil Interpretations. This facilitates updating and reevaluation as new information becomes available. Volume II was written in part by community planners. Some of the interpretations were developed locally. The planners requested map preparation at 1:24,000 to fit USGS 7.5 minute quads. SCS was reluctant but complied and now plans that future surveys published in California be at the same scale.

* Plant and Soil Science Department, Montana State University, Bozeman, Montana.

Soil Survey representatives of most Western State Experiment Stations participate in a regional research project (W-125) entitled, "Soil and Socio-Economic Criteria for Land Use Planning". This is a multidisciplinary effort with leadership from pedologists and economists. Chairman, Al Southard, has summarized under three objectives, the activities reported by project participants at Denver in November.

Objective I - Determination of the physical and socio-economic causes and consequences of encroachment by urban activities upon rural lands: California studies demographic trends in the San Joaquin Valley and the disposition of recreational and second home lots in Plumas County. Colorado investigates the transfer of water from agriculture to domestic use. Montana published a case history of the Big Sky recreational second home development and also produced a 27-minute film on land use planning issues in the area, New Mexico investigates the community cost-benefit effects of residential land development. Oregon completed a land use inventory of the Willamette Valley. A computer data storage system is used to examine the influence of soil suitability upon development patterns.

Objective II - Identification and organization of kinds of soil data and interpretations needed for present and potential clientele: Arizona is completing a state soil map and bulletin at 1:1,000,000 scale. Colorado is developing a land capability data base for all counties. "Land opportunity and limitation maps", will be developed. Soil data needed to evaluate the impacts of oil shale development are also being investigated. Hawaii will test a model for rating alternative land uses. Montana published a list of factors that influence choices among alternative land uses. A Resource Inventory Handbook for counties is being prepared at the request of participants in land use conferences. Nevada is working on definitions of kinds of soil surveys and a system to determine the level of soil survey needed to satisfy specific interpretive demands. Oregon completed a resource inventory of Croak county with maps on ERTS imagery at 1:1,000,000 and 1:250,000 scale. Land resource units were developed with interpretations. A state soil map is in progress. Utah published a general soils map of the state. A soil survey and interpretive report of the Ogden Valley was published for county planners and serves as the basis for land use plans.

Objective III - Evaluation of the adequacy of present data and the development of new data, interpretations and procedures to overcome soil limitations: California is continuing the use of rain simulators to evaluate erosion. Colorado is developing a system to evaluate performance zoning to encourage agricultural land preservation. Hawaii is evaluating soils in order to rate the land for its agricultural potential. Montana has compiled the engineering data for soils of the state and is developing methods to rate landslide hazards in mountainous areas. The Decker storage and retrieval system for pedon and mapping unit descriptions is operational statewide by the SCS. Nevada and New Mexico are developing improved methods for measuring or estimating soil permeability. Oregon continues work on septic tank filter field performance and has expanded to hill-slope analysis using tagged water.

Other cooperative projects for soil survey in the West include: 1) A soil taxonomy workshop in Portland, December 2-6, 1974 for soil classification leaders. 2) A 35-mm slide series illustrating diagnostic horizons and soil taxonomy, soon to be advertised and distribution by the Western Soil Survey Work Group. The series is drawn largely from the collection of William M. Johnson. 3) Efforts toward state legislation to license or certify professional soil classifers. Clint Mogen has summarized this activity.

Soil Surveyor Organizations and Legislation in the Western Region.

State	Professional Title	Professional Organization	Status as of January 20, 1975
AK		--	No information
AZ	No	Organizing an Association	Discussion stage
CA	Soil Classifer	Soil Classifiers Association	*
CO	NO	No	Discussion stage
HI		—	No information
ID	Soil Scientist	No	Legislation introduced
MT	Soil Classifier	No	Legislation introduced
NV	No	Possibly organize with California	Discussion stage
NM	No	Soil Science Society	Discussion stage
OR	Pedologist	No	Legislation to be Introduced
UT	No	No	Discussion stage
WA	Soil Scientist	Society of Professional Soil Scientists	Legislation to be introduced
WY	No	No	Discussion stage

* Estimated annual administrative costs of $50.000 may require registration with geologists who are already organized and licensed in California.

USE OF SOIL SURVEYS BY THE AGRICULTURAL RESEARCH SERVICE [1/]

H. L. Barrows [2/]

It is a pleasure for me to appear before this group this afternoon. Those of us in Soil, Water and Air Sciences of ARS feel a partic-ular close bond with the Soil Conservation Service. As you will recall at one of our earlier reorganizations most of the research portion of SCS was transferred to ARS and became a portion of the Soil and Water Conservation Research Division. Since that time we have attempted to respond to the research needs of SCS. In fact, most of our research programs in Soil, Water and Air Sciences are in direct response to your needs. We have valued this close cooperation in the past and hope that it will continue.

I have been asked to discuss with you some of the soil survey activities that affect or are used by our agency in our research program. There are, of course, many of these and I will only be able to cite a few examples here this afternoon.

The Agricultural Research Service has seven major research water-sheds in the United States. Most of these watersheds have been surveyed and the soils classified by SCS. This was done so that the research information could be transferred to ungaged watersheds having similar soil conditions. This approach has paid off in our hydrologic modeling efforts. A good example of this is the USDA Hydrograph Laboratory model which is based on the SC6 classifica-tion system.

1/ Presented at the National Soil Survey Conference, Orlando, Fla.. January 27, 1975.

2/ Deputy Assistant Administrator, Soil, Water and Air Sciences, Agricultural Research Service, U.S. Department of Agriculture. Washington, D.C.

Our erosion research has benefited considerably by the availability of soil survey data. For example, the K values for the Universal Soil Loss Equation are keyed into the SCS soil classification system. Wind erosion research is also benefited. Our scientists can develop theoretical models with little dificulty, but until they have been tested, they are of little value. These tests must be made under varying conditions, but it is essential that we have accurate descriptions of the soils to be tested. Not only have we had the benefit of SCS data to help us in this, but SCS personnel often work with our scientists in selecting the specific site to be tested.

Our research on water use efficiency relies very heavily on soil survey data. Our scientists in the Pacific Northwest are attempting to develop soil management practices that will reduce erosion and utilize water more efficiently. They have developed tillage systems based on soil survey data. The type of system to be followed is dictated by the soil conditions. What will work for a sandy soil is not at all adequate for finer textured soils. Research on irrigation, drainage, and reclamation of salt-affected soils utilize soil survey data. In fact, SCS personnel assisted in selecting the site of one of our more recent studies on the use of salt-affected soils. This project, located at Grand Junction, Colorado, is utilizing varying irrigation rates to control salt leaching. It is anticipated that an irrigation schedule can be developed that will permit crop production on these soils without increasing the salt content in the return flow.

We are working very closely with SCS in identifying soil characteristics associated with crop yield and quality. For example, through this joint effort, ve have been able to Identify those areas in the United State6 where selenium in the crops will be toxic to animals, and those areas vhere the soil cannot furnish adequate levels for animal health. We are doing the same kind of work for other micronutrients--both essential and, possibly, toxic.

Infiltration data and soil structure, including the presence of pans, have been very helpful in our work on water quality, particularly as it may be affected by fertilizer nitrogen contamination, Our nitrogen leaching study plots at Lincoln, Nebraska, were selected by SCS personnel.

Perhaps the most recent use we have made of soil survey information is in the work we are now doing in cooperation with EPA to develop guidelines that can be used by individuals or agencies charged with responsibility for developing plans to control nonpoint sources of pollution as required under PL 92-500. It probably would be advantageous to discuss this effort with you in just a little more detail. We plan to develop a two-volume document. Volume I, now in draft form, is designed to be a user's manual in which the process of identifying a specific potential problem, and the corrective measures that can be taken can be followed from a direct sequence of instructions. Volume II reviews the appropriate basic principles on which the instructions are founded, provides documentation of the information presented, identifies gaps in our present knowledge, and makes recommendations for research that is needed.

The Agricultural Research Service relied very heavily on information that has been made available by SCS and soil surveys in developing the format and the guidelines presented in the documents. For example, we use the "land resource area" as the basic unit in identifying potential pollution problems and their control. Within each of the 156 resource areas it is possible to further subdivide potential problem areas. Again, this is based on SCS concepts of soils, climate, topography, and ground cover conditions.

Despite the tremendous effort that is now going into modeling, our scientists relied on the SCS curve number approach to predict runoff from a given storm rainfall. They felt that this was the only available method that could be readily used in a national assessment. Of course, we do have some problems with this approach in portions of the western United States because of very steep rainfall gradients. We have, however, prepared a map depicting the average annual, potential, direct runoff for the United States.

Erosion is estimated from the Universal Soil Loss Equation. Of course, the basic concepts for this equation were developed and tested by ARS scientists, but SCS has used this equation extensively and has K *factors* for the predominant soils within a resource area. The leaching or percolation factor presented in the handbook is, again, based on the results of soil surveys. Prom this and meteorological data we have developed a map of the United States showing the average annual, potential percolation from various resource areas.

Without the tremendous information now available from soil surveys, it would have been impossible to develop a guideline that could be utilized to implement the nonpoint source phase of PL 92-500. While soil surveys are proving indispensable in the program of ARS there are gaps that we feel need to be given more attention. For example, we do need better data on mapping units as they relate to such items as land application of waste, fate of pesticides, erosion, and land to be disturbed through mining operations. During the last two years there has been a modeling explosion. The success of predictive models will depend upon the reliability of available physical and chemical data on a mapping unit or other genetic classification. This probably will require a combined SCS-ARS effort.

A lot of old faces have disappeared from both our agencies. These were the people who knew each other on a first-name basis and really made the cooperative effort operate. We have new faces now in many leadership positions. It is important, in my opinion, that we make sure that these people get to know each other on a first-name basis, learn what each agency is doing and be aware of their needs. By doing that, we can assist each other and accomplish far more together than what could be done by each agency working alone.

Presentation of:

Wesley R. Booker
Soil conservationist
Bureau of Indian Affairs
Washington, D. C.

It is indeed a pleasure for me to attend and participate in the National Soil Survey Conference again. I have the privilege of representing the Bureau of Indian Affairs as I did two years ago. There is, however, a significant difference this time. Two years ago I was the Bureau's Acting Soil Conservationist, on detail from my duty station in Idaho. This time I'm happy to announce that I have been appointed to that post and am now officially the Bureau's Soil Conservationist.

I have been looking forward with a great deal of anticipation to seeing old friends, renewing acquaintances and making new friends at this conference. There is one man in our midst, however, that I want to give a special word of greeting. I owe him a great deal because it was through his efforts that I received my basics in soil surveying (and somehow kept my job). He issued me an old Ford pickup, some aerial photos and a "sharpshooter" shovel, told me 1,000 acres a day was expected of me, then proceeded to teach me how to make soil surveys. That was in Mayville, North Dakota when we were both employed by the Soil Conservation Service. Hollis Wesley Omodt, I thank you.

The soil survey effort in the Bureau of Indian Affairs is perhaps more important today than ever in the history of that effort. We are actively involved in collecting soils data for management planning and development of farmlands, both irrigated and dryland; for improvement, management and development of grazing lands; for management and improvement of forest lands; for recreation, commercial and community developments; for highway and other construction programs. We are also very much involved in surveys for and evaluation of environmental impact statements. Last, but perhaps most important to the Indian people are the soil surveys conducted specifically for the protection of the statutory rights of those people.

In Fiscal Year 1974 a total of 1,736,000 acres of Indian lands had soil surveys made. In Fiscal Year 1975 we expect to complete soil surveys on 2,280,000 acres of Indian land. Currently our total Soils staff numbers 30 positions, two of whom operate our soils laboratory in Gallup, New Mexico.

As you can see our staff is limited. We, therefore, accomplish a number of our surveys by cooperative arrangements with other governmental agencies (primarily SCS) and by contract with private concerns. Those kinds of arrangements will no doubt continue to increase in coming years. As they increase it becomes almost mandatory that we all use one universally accepted system for the surveys we make - I hereby pledge my support of the National Soil Survey Conference effort in perfecting and implementing a uniform system, designed to be useable by all Agencies. At the next conference I hope to report to you how the Bureau of Indian Affairs made the conversion.

Thanks again for extending an invitation to participate in the conference.

STATEMENT PRESENTED TO
NATIONAL SOIL SURVEY CONFERENCE
Orlando; Florida - January 27, 1975

James S. Hagihara
Bureau of Land Management

The Bureau of Land Management appreciates the opportunity to participate in this conference. We also extend our thanks to the Soil Conservation Service for their excellent cooperation and assistance in related soil survey activities.

We are continually increasing and improving our efforts in collecting and utilizing soils data to satisfy planning and development of multi-resource management programs on the National Resource Lands (NRL). During the past year the "energy" crisis and requirements to satisfy the National Environmental Policy Act has created a greater demand for more and better soils data for the protection and enhancement of our environment. The present mineral "energy" situation has really accelerated the BLM soil activities in the western states. The proposed strip coal mining operations has created a great and urgent need for better soils information that will assist in rehabilitation and reclamation of the disturbed lands. Sound basic soil information is also required to manage the national resource lands under the multiple use concepts.

Current Activities

Since our last report to this conference the BLM has made substantial progress in developing the soils functions within the Bureau. Currently BLM has 30 Soil Scientists located within the 11 western states as compared to 16 a year ago. The primary assignments of the BLM Soil Scientists will be: (1) to collect and inventory soils data, (2) make practical interpretations that will assist in making multi-resource management decisions, (3) assist the resource managers in the application and use of soils data. Thus far our soil scientists have completed mapping approximately 4,000,000 acres of NRL located in Oregon and California. These lands were mapped in accordance with the cooperative National Soil Survey procedures.

Considerable progress has been accomplished on the extensive Watershed Inventory of the 450 million acres of National Resource Lands under our administration. As of October 1974 we have inventoried nearly 126 million acres. It is anticipated the Watershed inventory of the 180 million acres located in the eleven (11) western states will be completed in FY 76. The Watershed Inventory includes. collection of vegetation, soils and erosion data on a broad level. This information will be used in developing long range resource management plans.

Another activity requiring soils information on the NRL is the Colorado River Salinity Program. The BLM has been assigned the-charge to (1) identify point, and diffuse sources of saline waters and (2) identify and determine soils that have potential to produce saline runoff in the Upper Colorado River Basin. The purpose of the program is to develop resource management plans for reducing and controlling saline runoff from NRL that enter the Colorado River.

Cooperative Soil Surveys

1. Cooperative Soil Surveys with Soil Conservation Service,

The Soil Conservation Service is mapping nearly 4.5 million acres during FY 75 under reimburseable cooperative agreements in the following states:

Arizona	1,390,000 acres
California	59,000
Colorado	155,000
Idaho	195,000
Montana	1,200,000
Nevada	1,400,000
Utah	118,000

We hope to continue mapping at this level through cooperative agreements with the SCS, however, this will depend upon future funding and capabilities of the SCS to accomplish the mapping.

2. Cooperative Soil Investigations with the Bureau of Reclamation (BR).

During FY 75, the BLM entered into a cooperative agreement with BR for soil investigations upon nearly 100,000 acres located in Montana, Wyoming, Utah and Colorado.

These soil investigations are concentrated primarily in the high potential energy, mineral resource areas. The objectives of the soil investigations are to collect baseline soil data that will assist in defining, analyzing and developing alternative rehabilitation practices for surface disturbed areas. Thus far, 4 sites totalling 2,000 acres each have been investigated near Colstrip, Montana, Hanna. Wyoming, Craig, Colorado, and Kanab, Utah. Approximately 200,000 acres are scheduled for investigation during FY 76. These investigations include detailed mapping of soils, complete physical and chemical analysis of the surface and subsurface to a depth of 200 feet. The drill hole investigations also include mineral, geologic and underground water studies,

Problems

1. Training and Technical guidance of the newly hired soil scientists can become quite a problem as our soil activities accelerate. Many of the newly hired soil scientists are recent graduates in soils from the various universities. Although they are well qualified and have the academic requirements, many lack the necessary field experience. The BLM hopes to provide the necessary field experience and training to the newly hired soil scientists by working with the Soil Conservation Service and other agencies that have this kind of expertise and on-going training programs, In the interim, we are developing a formal training and technical guidance program for our new soil scientists which we hope will bring them to their full productive capacity in as short a time as possible.

2. Another problem is the use and application of the soil data that has been collected by our soil scientists and through the cooperative soil surveys.

We are developing a program in which we hope to train the resource managers or users upon the use and application of soil data in making multiple use resource management decisions.

We propose to accomplish this by involvino the resource managers during the field mapping and development of management interpretations.

We have also learned that in addition to teaching the resource manager how to use the soil survey report, he must learn how to relate soil behavior to various land treatment practices that will be applied. Thus, the soil behavior section is very important to the user.

Conclusion

All of us are involved with collection and application of soil survey data for many purposes ranging from urban to remote, mountainous areas. Conferences such as this, provide us with an excellent opportunity to exchange ideas and information that will make soil surveys effective.

USDA-SCS NATIONAL SOIL SURVEY CONFERENCE
Orlando, Florida, January 27-31, 1975

USDI BUREAU OF RECLAMATION ACTIVITIES1/

Soil Science and related activities of Reclamation programs primarily relate to water and land resource development. They include multipurpose land classification in determining land use suitability for multiobjective planning; economic land classification, wetland surveys, and drainage and reclamation of salt-affected lands on existing irrigation projects; soil characterization for irrigation scheduling; revegetation of lands disturbed through construction of project features; reclamation of lands to be surface mined of mineral deposits; soil inventory in areas potentially affected by development of mineral resources; land and water appraisals for environmental studies; remote sensing research; predicting quality of return waterflows into drainage systems; water quality control, particularly salinity of major river systems; soil investigation for other agencies; assistance in selection of lands for irrigation to foreign countries and international financing organizations; and participation in interagency affairs, on committees, at workshops, and professional societies. A portion of the lands surveyed for salinity and all the work on soil inventories and reclamation of mineral extraction are performed for the USDI Bureau of Land Management through contractual arrangements. The soil inventories for BLM are described in the presentation by Mr. James S. Hagihara.

It is Reclamation's practice to utilize USDA-SCS soil survey information to the fullest extent possible in all activities for planning construction, development, settlement, operation and maintenance, and rehabilitation of projects.

Reclamation of Coal-Mined Areas

The studies for BLM on reclamation of mineral areas are in response to the "coal rush" in meeting the energy crises. The objective is to identify optimum coal-leasing sites having superior potential for reclamation and to formulate lease stipulations. This involves obtaining basic data; making evaluations; and developing standards, guidelines, techniques, and aiternate plans for land rehabilitation

---

1/ William B. Peters, Head, Land Utilization Section, Resource Analysis Branch, Division of Planning Coordination, Engineering and Research Center, U.S. Department of the Interior, Bureau of Reclamation, Denver, Colorado.

and restoring vegetative growth. The plans will include recommendations for deposition and treatment of overburden and measures required to minimize environmental impacts, air and water pollution, and to promote safety. Environmental planning, design, and engineering are a very important aspect in formulation. Where viable alternative opportunities for enhancement are identified, plans will be developed as requested by BLM. Alternative land uses and potentials might include rainfed agriculture differing from present cover and enterprises, irrigated agriculture, wildlife habitat, recreation, homesites, industrial developments, and others. In this planning, analysis will be made of land use problems and opportunities associated with water plans, recognizing the natural and a modified land base, existing and potential land use patterns, zoning regulations, and general relationships to environmental social, and economic aspects of the setting. All plans developed will include an assessment of cost and benefits.

The work is being approached on an interagency and interdisciplinary basis. Reclamation, in cooperation with the USDI Geological Survey, is exploring and characterizing overburden, 2/ surface and ground water, and developing and analyzing data with respect to geology, engineering, plant science, hydrology, soils, drainage, economics, ecology, environment, and other relevant considerations. The investigation with respect to lands largely involves characterizing the overburden for reclamation potential and determining land use suitability. In characterizing overburden, sufficient exploration and drilling are accomplished to describe and collect representative samples of soil, subsoil, and substrata to a depth below overburden and coal (maximum depth of 200 feet). The description of soil, subsoil. and substrata characteristics in relation to land characterization essentially conforms to the USDA National Cooperative Soil Survey procedures. Sampling of overburden at master sites and agronomic laboratory testing is on a comprehensive basis. At the other explorations and borings, representative samples are selected for laboratory characterization on a screenable basis to confirm judgment in field appraisals.

The first priority in the agronomic laboratory characterization of soil is directed toward direct and indirect measurements to evaluate soil structure and its stability, effective soil cation exchange capacity, and soil reaction. After this is accomplished, then consideration is given to testing that confirms the field characterization, explains the causes of phenoma previously

2/ Overburden is the material consolidated or unconsolidated, overlying the coal.

observed or predicted, reveals the presence of toxic elements (salinity level, boron content. alkali, acidity, reduction products, etc.), and indicates measures required to cope with the soil deficiency under eventual field conditions.

Selected samples found by the laboratory testing to represent a range in properties conducive and adverse to establishment of vegetation are further subjected to greenhouse studies at Colorado Experiment Station, Fort Collins, Colorado. These greenhouse and related studies are designed to establish possibilities and methods for establishing vegetation. Should these studies identify or detect unforeseen toxic conditions or soil deficiencies not susceptible to amelioration by established procedures, a program of applied research will be recommended.

A product of the characterization with respect to lands will be s resource map reflecting both the present condition and future conditions under alternative plans for reclamation and restoration. As mentioned by Mr. Hagihara, the Soil Survey aspects are being coordinated by BLM with SCS at State and local offices. The USDA Forest Service Surface Environment and Mining (SEAM) serves as a consultant to BLM on coordination matters.

Concurrently with the above-described investigations, the overburden is also characterized for geological, hydrological, and engineering properties. The USGS is responsible for ground-water data collection.

This work was initiated last year at four specific sites, comprising about 2,000 acres each located "ear Ashland, Montana; Hannah, Wyoming; Meeker, Colorado; and Kanab, Utah. Studies at six additional sites are to be initiated this year and each of the following 3 years. Experience gained to date from this initial study and consultation with others lead us to believe rehabilitation of disturbed lands can be accomplished using procedures already developed. Soil testing and soil fertility evaluation are sufficiently advanced to prescribe optimum management practices for most conditions. Research is underway to further develop plants for erosion control. The principal obstacle precluding successful rehabilitation of disturbed lands has bee" the general lack of coordinated planning among disciplines, agencies, organizations, and activities. In this regard, Mr. Hubertus Mittman of the USDA Forest Service has emphasized the need for greater involvement and increased action by persons experienced in planning. Problems have to be anticipated and alternatives considered from a" interdisciplinary standpoint.

Reclamation by reason of experience in revegetation of disturbed lands and the many other facets, organizations, staff capabilities, facilities, and administration "know how" to coordinate the varieties of disciplines and activities is striving to provide leadership in meeting needs.

Irrigation Management Services Program

The Irrigation Management Services is a program developed by the Bureau of Reclamation to direct and assist irrigation and water districts in establishing programs to promote more effective and efficient use of their water supply. It is directed toward better on-farm water management and extending water management through the distribution and storage systems. While the program was initiated primarily as a research effort, the beneficiaries of the program are expected to financially support these programs in their operational stages. The results of these program efforts will be applied in the design of new projects or in the rehabilitation of irrigation systems. The establishment of the Irrigation Management Services Program on irrigation and water districts is a cooperative effort with the Soil Conservation Service and the State Extension Service.

Colorado River Water Quality Improvement Program

The purpose of this investigation is to develop plans for controlling salinity in the lower reaches of the Colorado River at or below present levels. The mineral burden of the Colorado River is the foremost water quality problem in the basin and carries both interstate and international implications. Continued development of the water resources is expected to generate additional salinity increases with concomitant economic losses to agriculture and M&I users if the salinity is not controlled. Natural sources contribute most of the salinity to the river. Return flows from irrigation and municipal and industrial uses also add significant quantities of salt. Moreover, concentrating effects are produced by water exports out of the basin, use of water by vegetation, and evaporation from free water surfaces. This investigation program will consider individual problem areas, develop control plans, and make specific recommendations for remedial action.

Under the program, appraisal and feasibility plans for control of salinity from irrigated areas and high salt input, point and diffuse sources are being prepared. To date the program findings on salinity sources are pointing toward a need to emphasize nonstructural salinity control measures. Support studies involving the preparation of a mathematical model for management of the river, economic evaluation of water quality, institutional and legal review are being made. Preliminary work has been completed on the applicability of ion exchange technology.

On the irrigation sources. irrigation scheduling techniques to improve irrigation efficiency are now being applied to 6,500 acres in the Grand Valley area, Colorado; similar work is underway on the Palo Verde Irrigation District, California; and the Colorado River Indian Reservation, Arizona. Irrigation scheduling work will be started in the Lower Gunnison Basin and in the Uintah Basin in the fiscal year 1974. To assure effectiveness in irrigation source control, feasibility studies of the conveyance and drainage systems are being made to disclose improvements that could be made which would achieve reductions in salt loading. Feasibility studies on point sources at LaVerkin Springs and Crystal Geyser in Utah ware completed in FY73. Studies at Paradox Valley in Colorado are progressing and work at Las Vegas Wash in Nevada will be initiated during the current year. Feasibility studies in Paradox Valley will be completed in FY75. An appraisal report is under preparation for Blue Spring. All other point sources and diffuse sources in the program involve basic data collection as a prerequisite to report preparation. These include Glenwood-Dotsero Springs and McElmo Creek in Colorado; Littlefield Springs and Price, San Rafael, and Dirty Devil Rivers in Utah; and the Big Sandy River in Wyoming. On the latter, pilot studies will be undertaken to appraise efficiency of desalting the water using natural freesing, i.e.. not a desalting plant per se but rather a process involving the use of the natural cold temperatures in the area to freeze the water and thereby remove most of the salt. Cooperative research with the USDA Agricultural Research Service has been started to evaluate the relationship between high irrigation efficiencies and reductions in salt loading.

Land Use Planning

The Soil Science Training Institute conducted at Colorado State University was, commencing in 1974, modified and supplemented to comprise a Land Use and Water Planning Institute for the years 1974 through 1976. Under the capable direction of Dr. Robert D. Heil, the 1974 course was structured to give top-level management personnel an overview of the interface between land use and water planning. The course emphasized the principles of land use planning including the physical, economical, biological, political, sociological, and other factors which are important in the development of viable land use plans.

To accommodate Reclamation needs in water development, the course was directed toward the following areas:

1. Basic land use planning considerations including ecological, physical, biological, economic, sociological, and political

2. Management and development considerations for uses other than irrigation such as recreation, wildlife, aesthetics, archaeological, urban, and suburban

3. Inputs required for adequate land use planning

4. Methods for inventorying land features to evaluate alternative land use suitabilities

5. Techniques and procedures in planning for reclamation and reuse of disturbed lands

6. Impact of land use changes in natural resource areas

7. Impacts of land use and its regulation on planning of water projects

Subsequent courses are to be directed toward needs in broadening and attaining greater technical proficiency among workers actually involved in investigations.

Remote Sensing Research

Reclamation continues to support research in remote sensing for many applications including land classification. Most of the Soil. Science activities have been in cooperation with the EROS Program and directed toward development of methods to assist in better identification of depths to water table, surface water accumulation and drainage ways. vegetative cover and crop identification, depth to root and water impeding barriers, and gross soil features including soil moisture and salinity.

This last year, our Research Division has been field testing a short pulse radar system. This is being developed for: (1) ground water depth measurement accuracy; (2) soil moisture content measurement; (3) soil layering detection. They were unsuccessful in attaining sufficient ground penetration.

A remote sensing contract was signed with the Texas Agricultural Experiment Station, Texas A&M University, College Station, Texas, June 3. 1974. The remote sensing is to be accomplished for the Elephant Butte Reservoir, Fort Quitman Project, New Mexico-Texas (RGREP). The objectives of this program art? twofold: (1) To investigate the utilization of remote sensing to assist in assembling resource and land use information for the regional plan of RGREP. Emphasis will be given to long-term development of available natural and human resources in order to realize their full potential within and environmental setting of high quality. (2) To investigate the application of remote sensing for the management of water resources in the RGREP area,

Approach. - It is anticipated that this study will be developed in three l-year phases to meet the outlined objectives:

Phase I - Development of information on agricultural and natural resources and land use as a data base for the RGREP area (fiscal year 1974).

Phase II - Data base expansion to include urban, suburban. and special land use categories and application of advanced sensor survey for monitoring water use in the RGREP area (fiscal year 1975).

Phase III - Investigation of remote sensing applications for monitoring and management of water resources in the RGREP area (fiscal year 1976).

In the Columbia Basin, Washington, ERTS imagery is being used to monitor new irrigation, primarily use of pivot sprinklers.

Summaries on land classification activities by States are presented in tabular form on Tables I and II.

Table I

IRRIGATION SUITABILITY LAND CLASSIFICATION

Fiscal Years 1974 and 1975

Arizona

Colorado River Indian Small Projects Loan

California

LaBranza Water District
Gravelly Ford Water District
Laguna Water District
Mid-Valley, Raison City
Rainbow Municipal Water District
Foster Municipal Water District

Colorado

Dolores Project
Uncompahgre Project

Idaho

Teton Phase II
Oakley Fan Unit
Ririe Dam Project

South Dakota

Brown County
Castlewood-Estelline Area

Utah

Ute Indian Unit

Table I - Continued

Washington

Yakima Project
Spokane Indian Reservation
Columbia Basin Project

Montana

Mill Iron Unit
upper Missouri Project, Lower Musselshell Area

Nebraska

Hid-State Division
North Loop Division
O'Neill Unit

New Mexico

Animas-LaPlata Project
Navajo Indian Irrigation Project

North Dakota

Missouri Souris Project

Oregon

Rogue River

Table II

MULTIPURPOSE LAND USE SUITABILITY CLASSIFICATION
FOR MULTIOBJECTIVE PLANNING

Colorado

- Basalt Project
- Dolores Project
- Uncompahgre Project
- Yellow Jacket Project
- Grand Mesa Project
- Dallas Creek Project
- Fruitland Mesa Project

Idaho

- Minidoka Northside Extension
- Upper Snake River Area

Oregon

- Willamette River Project
- Rogue River Project

Wyoming

- Sublette Project

SOIL SURVEY RESEARCH IN THE STATE EXPERIMENT STATIONS

BY
Eilif V. Miller
Principal Soil Scientist
Cooperative State Research Service

The Cooperative Soil Survey has long been an effective mechanism for joint involvement of the State Agricultural Experiment Stations with the Federal Soil Survey under SCS. The directions which such cooperative work is taking in the various states is a glaring example of the diversity which characterizes American science and technology. In some states there is extensive involvement of the Station in present programs of mapping. In some there are other units of state government which have increased the inputs made by the state to the total effort.

The Cooperative State Research Service (CSRS) of the U. S. Department of Agriculture (USDA) works closely with the Experiment Stations and provides funds for the support of research, broadly defined, in the field of soils and soil survey. By using the Current Research Information Service (CRIS) data bank which records all research projects in the State-Federal system, one is able to keep informed about the state funded projects as well as those supported federally by CSRS.

Looking over a printout of all soil survey projects in the system, we find that approximately equal numbers of projects are receiving primary support from CSRS and from state appropriations.

Table 1 shows that out of 101 total research projects underway in 1974, 50 were supported by CSRS and 51 by state funds. There is no subject-matter distinction due to the sources of support for station projects.

Table 2 presents the major subject-matter fields investigated in soil survey research projects of the State Experiment Stations tabulated in order of frequency of occurrence. The subject of correlation, classification, and mapping was a major part of 24% of the projects, closely followed by soil survey interpretations, 21.5%, and soil profile characterization and taxonomy, 20.5%. Land use planning, a subject of increasing importance in soil survey research was a major part of 17% of the projects.

Table 3 indicates the output of research publications from the 101 projects summarized. It should be noted that the flow of publications from any given state is extremely uneven as shown by the large number of states which had none in 1973. There is also a difference in the way research publications were defined in different Stations.

TABLE 1. Sources of Soil Survey Research Support, 1974

Primary Source of Support	Number of CRIS Projects
Hatch Act Funds, CSRS	44
McIntire-Stennis Act, CSRS	4
Public Law 89-106, CSRS	2
State Appropriations	51
TOTAL	101

TABLE 2. Major Subjects of Soil Survey-Related Research Projects, 1974
State Agricultural Experiment Stations

Major Subject-Matter Fields	Frequency in 101 Projects*	%
Correlation, Classification. Mapping	33	24
Soil Survey Interpretations	29	21.5
Soil Profile Characterization, Taxonomy	28	20.5
Land Use Planning	24	17
Remote Sensing, Data Banks	12	9
Genesis and Morphology	11	8
TOTALS	137	100

*The excess frequency of occurrence over the number of projects is due to the occasional occurrence of more than one major subject-matter field in one project.

TABLE 3. Publications Reported from Soil Survey Research Projects, 1974
State Agricultural Experiment Stations (CRIS)

NORTH CENTRAL		NORTHEAST		SOUTH		WESTERN	
Alaska	0	Conn.	3	Ala.	1	Ariz.	0
Ill.	4	Del.	0	Ark.	2	Cal.	4
Ind.	1	Me.	0	Fla.	6	Colo.	3
Ia.	4	Md.	4	Ga.	0	Guam	0
Kan.	5	Mass.	0	Ky.	2	Haw.	0
Mich.	1	N.H.	0	La.	5	Ida.	0
Minn.	8	N.J.	1	Miss.	5	Mont.	4.
Mo.	3	N.Y.	S	N.C.	1	Nev.	2
Nebr.	3	Pa.	32	Okl.	0	N.M.	2
N.D.	1	R.I.	0	P.R.	0	Ore.	9
0.	15	Vt.	0	S.C.	0	Ut.	3
S.D.	11	W.Va.	0	Tenn.	2	Wash.	3
Wis.	0			Tex.	3	wyo.	0
				Va.	2		
				V.I.	0		
TOTALS	56		48		29		30

North Central	56
Northeast	48
South	29
Western	30
Total	163

Research chapters which were published as part of soil survey reports were usually listed as research contributions from the project. In some Stations the publications listed were mainly journal articles. The summary by regions shows that 163 research publications were prepared during the 1973 project year. The North Central Region reported the largest number, 56 publications from the 13 Stations in the Region.

In addition to the individual station research projects reported above there were 2 active cooperative regional research projects relating to soil surveys and their use in land use planning. Their titles and contributing projects from the cooperating stations are given in Appendix 1. These projects, like all regional research under the Hatch Act of 1887, are supported in part by Federal monies (the Regional Research Fund) and in part by other resources of the stations, part state and part Federal.

NC-109 in the North Central Region is concerned with the characterization of soil landscapes to make soil survey information more useful in land use planning and rural development. The cooperators are preparing state soil maps and planning guidebooks as well as other kinds of interpretive data usable by soil survey clienteles.

W-125 in the Western Region is concerned with urban encroachment on rural areas and the kinds of knowledge needed by the affected people to use soil survey information in land use planning. The cooperating scientists are concentrating upon the organization and mobilization of soils information including the preparation of interpretation manuals for the lay person.

The Regional Research Fund under the Hatch Act is extremely important to the achievement of greater coordination and scientific uniformity between states in the application of research. Twenty-five percent of the Hatch Act funds (which now amounts to $77 million per year) is devoted to agricultural regional research of all kinds. It is possible that more of this kind of innovative cooperative research is needed to achieve full benefit from soil surveys by broadening their usefulness. New clienteles exist for the soil survey and attainment of the correct interpretation of the data will be a continuing duty of soil scientists.

There is another side to the state soil survey research picture in the United States which is definitely negative in character. This is the long-term downward trend in Experiment Station support for research classified under RPA No. 101, Appraisal of Soil Resources.

Table 4 shows the trend in scientist-man-years (SMY's) devoted to soil appraisal research for the period from 1966 to 1973. The allocation of scientist manpower to soil survey research has been cut in

Table 4 Scientist Man - Years For State Agricultural And Forestry Institutions.

Research Problem Area 101, Appraisal of Soil Resources

SCIENTIST MANPOWER

YEAR	MAN YEARS	RELATIVE TO 1966
1966	136	100
1967	125	91
1968	126	91
1969	124	91
1970	95	70
1971	85	62
1972	84	62
1973	78	57

Source of Data: Inventories of Agricultural Research Current Research Information Service, CSRS, half in a period of seven years. This reduction comes at a time when the soil survey is attaining its widest usefulness in land use planning, especially for non-agricultural purposes.

In spite of the above evidence of retrenchment, there are many favorable signs of progress which give great importance to the training of a new generation of soil survey scientists in the land grant universities. It is more important than ever to conserve the concept of cooperation between Federal and state programs in this vital field.

APPENDIX 1

COOPERATIVE REGIONAL RESEARCH PROJECTS ON LAND USE PLANNING

A. NORTH CENTRAL REGION, NC-109:

Title: Soil Landscape Characteristics Affecting Land Use Planning and Rural Development.

Contributing Projects (1973):

State and University	Research Approach
Illinois (U. Ill.)	Development of interpretive materials for some of the newer audiences using 3 soil surveys of different publication dates.
Indiana (Purdue U.)	Employment of remote sensing and photo-imagery to percieve landscape units. Land resource maps and data banks to be developed for derivation of specific guides and tabular information usable by planners.
Iowa (Ia. state U.)	Examine 3 or 4 prevalent soil landscapes for disposition of municipal and residential wastes. Guides for rural land assessment are being constructed.
Michigan (Mi. State U.)	Study of the relative adequacy of present and past soil survey maps. Transect studies, intensive grid analysis and remapping have been employed. Purpose is to obtain wider immediate coverage of useful soils information for planning.

Ohio (O.State U.)	Critical examination of a recently urbanizing area to characterize the predevelopment hydrology and then to develop predictive criteria for this landscape. Project will also develop soil landscape guides for community planning, land use, and erosion.
South Dakota (S.D.State U.)	Will use technique of "density slicing" to examine remotely-sensed photo-imagery of selected soil landscapes. Guides for rural land assessment and tax equalization use have been published. A state-wide map of soil associations has been proposed to assist in preparing the Land Use Plan.
Minnesota (U. of Minn.)	Project is preparing a Minnesota Soil Atlas in 11 sheets to provide maps of soil-landscape units on scale of 1:250,000 usable for state planning. A two-level legend has been adopted. Level I showing geomorphic regions and Level II showing soil landscapes in which the Taxonomy unit is the family phase of a subgroup. The delineations are mostly greater than one square mile in area and include more than one series.
Missouri (U. of Mo.)	Special Reconnaissance Soil Association maps are being started in urban regions based upon existing maps where available, and some new mapping. Interpretive reports will accompany maps for use by regional planning councils.

Wisconsin (U. of Wis.)	Studies have been made on soil absorption of septic tank effluents with emphasis on pedon characteristics. Ratings are being made for soil units in the state soil map on suitability for liquid waste absorption, suitability for urban expansion, and erodibility.
North Dakota (N.D. State U.)	A Resource Inventory and Monitoring System is being developed. Emphasis is on the study of lands in relation to coal mining development and strip mine reclamation.

B. WESTERN REGION, W-125:

Title: Soil Interpretations and Socio-Economic Criteria for Land Use Planning.

Objectives:

1. Determine consequences of urban encroachment

2. Organize soils data and interpretations for potential clienteles

3. Evaluate adequacy of present soil survey data with a view to development of additional data and procedures

States Contributing to Each Research Objective:

Objective 1: Washington, Oregon, Hawaii, Montana, New Mexico, Utah, and California are conducting study of changes in pattern of land use and are selecting areas to study rate of conversion, development, location analysis, and natural resource features. Alternate land uses are postulated and conflicts analyzed.

Objective 2: Nevada, Montana, Oregon, California, Colorado, and Hawaii are preparing a regional interpretation manual to inform users about land use problem solutions.

Objective 3: California, Montana, Hawaii, and Washington are determining physical criteria which influence land use choice.

Six states are integrating soil and other resource data to facilitate display and use. Five states are measuring inherent soil-behavior-related properties, such as water logging or shrink swell potential and others. Colorado and Nevada are investingating the significance of taxonomic categories to interpretive uses. Oregon and Nevada are defining mapping units in terms of landscape variability to assist in making interpretive maps. Three states are accelerating mapping in areas where land use planning is imminently needed.

EXTENSION SOIL SURVEY EDUCATIONAL PROGRAMS 1/

It is a pleasure to visit with you about Extension soil survey educational programs and activities and to participate in this 1975 National Soil Survey Conference during this week. It gives me an opportunity to gain more familiarity with your programs and activities related to soil surveys and their use and it helps us in the Extension Service to gather some new and developing techniques that will make for improvements in educational programs to increase the effective use of soil surveys.

I plan to visit with you today about some of the educational programs and activities carried out by the Cooperative Extension Service to improve the use of soil surveys. Usually these activities are planned and carried out in cooperation with the experiment stations and the Soil Conservation Service and others such as the Soil and Water Conservation Districts and Extension councils and committees. The overall objective of the Extension educational effort is, "The effective use of soil surveys."

In this presentation today I will focus on educational programs and activities related to the distribution and use of the soil survey report. I would have you note that there are other educational activities at different stages of the report such as before and during the time of the field work in preparation for the report and also there are educational activities of a followup nature carried on after the publication and distribution of the report.

We look to the State Extension specialist in soil conservation, agronomy, and/or soils to take the lead for the Cooperative Extension Service. The specialist working with the representative of the experiment station and usually the state soil scientist of the Soil Conservation Service assist the local county or area Extension agents and district conservationist to plan and carry out the educational activities.

To illustrate how this is cooperatively planned and carried out, I would like to discuss with you an example. This is the approach used in Mississippi. At the state level the Mississippi state staffs have developed and entered into a memorandum of understanding. This is between the Mississippi Agricultural Experiment Station, Mississippi Cooperative Extension Service, and the U. S. Department of Agriculture Soil Conservation Service relative to responsibilities to introducing and using published soil surveys. The memorandum of understanding provides for assignments of responsibilities for each of the agencies; it includes what each party agrees to do in each of the activities. For example. the Extension Service agrees to make arrangements for county meetings including the program, to participate and assist in the planning and conducting the meeting for the introduction and distribution of the soil survey, participate in conducting any planned field tours, furnish publicity for introducing the soil survey and to assist other agencies in providing instruction on the uses of published soil surveys.

1/ Prepared by Harold I. Owens, Agronomist and Soil Conservationist, Extension Service, U. S. Department of Agriculture, and presented at the National Soil Survey Conference, January 27, 1975, Orlando, Florida.

The Soil Conservation Service agrees to advise other agencies prior to receiving publications to participate and assist in planning and conducting the meeting for the introduction and distribution of the soil survey, to participate in conducting any planned field tours, to assist In furnishing publicity for introducing soil surveys, to assist in making arrangements for county meetings, to provide cooperatively with other agencies instructions on the uses of the published soil survey. The experiment station agrees to participate and assist in planning and conducting the meeting for introduction and distribution of the soil survey, to participate in conducting any planned field tours, and to provide cooperatively with other agencies instructions on the uses of published soil surveys.

At the county level it is suggested that one or two meetings be held to introduce the soil survey. People attending the meeting should include farmers, soil conservation district commissioners, county supervisors, farm leaders, farm business leaders, farm credit groups, agricultural workers, business leaders, bankers, engineers, contractors, real estate developers, planning commissioners, and other users of the soil surveys. When two meetings are held it is suggested that one be for the farm and the other for non-farm. In addition, a followup series of meetings by communities might be desirable. The memoradnum of understanding includes joint responsibilities of the county agent and the district conservationist. It includes a list of groups, organizations, officials, agencies, and individuals to whom notification of publications and release of the soil survey report should be made and invited to the meeting or meetings.

The county meeting for introducing the new soil survey report in Pontotoc County, Mississippi, was held November 21, 1974. It was sponsored by the Pontotoc County Soil and Water Conservation District cooperating with the Cooperative Extension Service, the Mississippi Experiment Station, and the Soil Conservation Service. Appearing on the program were the soil scientist, the agronomist, Mississippi Experiment Station representative, the soil correlator, the Extension agronomist and the state conservationist. They dealt with the subjects on work involved in prepaing a soil survey report, the soils of Pontotoc County, soils interpretations for Pontotoc County, making use of soil survey reports, and the soils and the future.

In 1972, training meetings were held for the county Extension agents in each of the Extension districts called “land use planning seminars.” To help with these agent training meetings expertise was drawn from the State Extension staff, from the Soil Conservation Service and the experiment station. I am sure that these training meetings gave a boost to carrying out the charges and responsibilities included in the Mississippi memorandum of understanding and gave a boost to effective educational activities In Mississippi related to the use of soil surveys.

I would like to move now to pointing out some of the informational pieces, tools, and methods used to encourage the effective use of soil surveys. In Missouri the state Extension specialist in land use has developed an exercise called “Soil Survey Exercise" which is designed to help familiarize landowners and operators with soil survey data and how to use the data contained in the soil survey report. The specialist uses this exercise with groups in educational meetings. I am sure that he makes the exercise available to the county Extension staff and area agronomists so they can use it in followup activities.

Some soil testing laboratories ask for the soil type on the soil sample information form. This supplements the chemical tests data and makes for improved soil treatment recommendations.

States publish maps and narrative data on the status of soil surveys in the state. An example is the March 1974 Research Report published by Michigan State University Agricultural Experiment Station.

South Dakota has delineated 39 soil associations using the Earth Resources Technical Satellite(ERTS) mosaic base map. In addition, tables are printed on the back of the map containing soil test results for the 39 soil associations. The legend shows the general soil textures, soil slopes, and land forms of South Dakota. Smaller maps on the handy folder delineate soil parent materials, physical division, dominent soil textures, growing degree days, and average annual precipitation and mean temperature. The Extension agronomists report that they plan to use this pamphlet as an educational tool.

Indiana is rating the productivity of the soils of the state. This is a cooperative activity between the Soil Conservation Service and the Cooperative Extension Service personnel. They report that with the “productivity index” they have a good method of comparing the net value of one soil to another, the productivity indices can form the basis for improved agricultural and open lands assessment. It gives the local assessor a ready opportunity to equate the soil resources of one farm to the soil resources of another.

Oklahoma State University Extension has published the circular Soil and Its Relation to Urban Development In the Tulsa County Area, which is designed to guide teachers of science, conservation. geography. and environmental studies as well as home owners, builders, land developers, planning and zoning commissions, and other concerned with the use of land resources.

In the Washington office of the Extension Service we have worked cooperatively with the SCS soil survey publications staff to notify the state Extension specialists of soil survey reports to be published in the near future. This notification reminds them to initiate plans for introducing the survey to the local people in the county or area. It suggests that they consult with the SCS state conservationist and their experiment station and others and ask them to participate in the planning process. We indicate some of the different audiences that should he interested in the soil survey publication. We then mail them a copy of the newly published report. This is their notification that it is published.

During the three month period from October to December 1974, we have recieved 24 new soil survey reports and distributed them to the state Extension specialists who have educational responsibilities related to the distribution and use of soil surveys.

The state Extension specialists have expressed their gratitude for the advance notice and the copy of the report. We have generally had good results with this procedure. Occasionally we do have a problem of delay in the publication which causes some frustration in the field. Also, on the opposite end of the scale, we have experienced receiving the publication with only about two weeks notice which also causes some frustration and surprise, with cranking up plans for educational activities in connection with the distribution of the report. We continue to work closely with the Washington SCS soil survey staff to make this procedure work as well as possible and be of assistance to the field staff.

Thank you for this opportunity to visit with you.

National Soil Survey Conference

Orlando, Florida
January 26-31, 1975

W.A. Wertz
Forest Service, USDA

For some years, the U.S. Forest Service has been reporting to this conference to emphasize mainly our concerns for devising best ways to collect, evaluate, and use soils information for the management of our National Forest System lands. We have stressed our need for a soil survey system geared to imnediate and practical use, and we have highlighted also the interdisciplinary nature of our approach to soil survey.

These concerns still apply, but we think we can say now that we have a program for soil survey in the Forest Service which is fully operational, and which is effective in meeting our needs. We have a skilled staff of at least moderate size. We have a sound background of success in soil survey and its application, and we experience a very satisfying demand for our product.

Let me comment briefly on these three points -

For soil survey operations, usina soil survey in its broadest context to include all soils activities of our National Forest System, we now employ 165 Soil Scientists. This is not a large number of scientists, but it represents a steady qrowth from our beqinninq in 1955. to a staff of 10 in 1956, 80 in 1966, and a doubling of our staff since 1966 in the face of some very severe manpower ceiling and dollar limitations.

Our staff of soil scientists is organized on a decentralized basis - working out of nine Regional headquarters and approximately 110 National Forest locations. Our first line field soil scientists have responsibility for the total soils program at these National Forest locations as they provide the full ranqe of expert soils consultant service to a multi-resource land management effort, and conduct the necessary soil survey field work and coordinating activities as well.

Many of you have a personal acquaintance with our soil survey experiences. We have completed over 24,000,000 acres of soil survey on National Forest lands as a part of the National Cooperative Soil Survey. This work has been correlated in partnership with the agencies here at the standard detailed level of soil inventory. Additionally, and in direct response to our needs as I noted earlier; best methods, immediate and practical use, and interdisciplinary requirements; we have completed over 65,000,000 acres of Soil Survey at the "reconnaissance level." These surveys in total represent our Soil Resource Inventory program which is aimed specifically at providing soils information in a manner commensurate with other data inputs for completing the comprehensive land use planning for all Rational Forest System lands within a designated time frame.

Our report to you this year is given with a flavor of optimism and a good degree of satisfaction. Our Soil Scientists do indeed share a great pride of accomplishment in having pained recognition throughout the Forest Service of the value of their product. We define this product as a response to demonstrated needs for soil information along with a completed follow through for its use in the long range and short term land use and resource planning as well as for immediate implementation at the operational project level. We take special oride in noting that the demand for our product grows faster where it has been tested under the most adverse conditions. We feel we have gained our recognition through a good mixture and careful balance of adherence to the profession of soil science in concert with a response to immediate and practical needs. We look forward to a continued and growing success in bringing the application of our soil science to bear in the day to day management of the National Forest System lands and resources.

I want to again express our appreciation in the Forest Service for the benefits which accrue to us from the Cooperative Soil Survey. We think some very helpful progress has been made recently for example, b.v the committee on kinds of soil surveys to facilitate better expression of our work and we are anxious as well to receive the new soil taxonomy publication and the revised Soil Survey manual. We intend to continue to make our meaningful contribution for the soil survey of wildland areas as a part of this national effort.

In looking ahead, we see a need to speed up the construction and use of our computer oriented technical information processing systems and of remote sensing techniques for soil survey. We see also a need for an expanded research and far better quantification of soil survey interpretations to meet the requirements of the fast growing sophistication of management on the National Forests and other forest and rangelands. We remain concerned about the recruiting, initial training, and continued education of our Soil Scientists. We are especially anxious to see an increased integration of the earth sciences and related disciplines for a sophisticated use of the soil survey for natural ecosystem identification, analysis, and management.

These kinds of accomplishments will truly tax the ability of the National Cooperative Soil Survey to adapt to our changing times. William Johnson, Assistant Administrator for Soil Survey, Soil Conservation Service, expressed this thought well at the 1974 Western Regional Work planning Conference when he said in part, "We have improved our efficiency greatly, and have expanded the number and varieties of interpretations of the Soil

Survey, but this is not good enough. We still have a large backlog of unpublished soil surveys. Our technology is till too traditional, too slow, and too narrow. There are too many people who do not know that the soil survey exists and too many who fail to see the need to base their land use decisions on facts about the soil. How can we overcome these difficulties? What is our objective and what is our timetable?" We in the Forest Service agree with Mr. Johnson, and we hope this aroup can answer his questions. We think the key does in fact lie in our ability to adapt to the chanqinq times.

SOIL SURVEY OPERATIONS

Dr. John E. McClelland*

Soil survey operations has experienced some changes since the last conference and I expect they will continue. Many of the changes are a result of procedures specifically designed to accelerate the publication of soil surveys. Some have been under consideration for a longer time and just recently approved for use. All are intended to improve the usefulness of soil surveys and help make the information available in a more timely manner. A backlog of unpublished surveys has accumulated and has continued to increase, This backlog must be greatly reduced during the next few years.

I have heard some concern expressed about maintaining high quality of soil surveys with the implementation of procedures to accelerate publication. Quality is still a primary objective of the National Cooperative Soil Survey. Quality and acceleration need not be incompatible. We can have both; each must receive the proper emphasis. Experience has shown, for example, that a soil survey completed in 5 to 7 years has a greater potential for higher quality and more utility to the user than a comparable survey that takes 12 to 15 years to complete. The new procedures should give us the opportunity to take the more desired course.

The acceleration of soil survey publication requires greater emphasis on effective long-range planning in soil survey operations. The large backlog of completed surveys must be reduced, but not at the expense of greatly curtailing the start of new soil surveys needed to meet current program commitments. The accelerated program is designed to facilitate publication of soil surveys in progress as well as those being started. Broader coordinated planning and programs for advance scheduling will need to be implemented. Presently, only those surveys on the 3-year publication schedule are closely monitored. This schedule will need to be lengthened to accommodate the timespan of all active soil surveys.

To meet long-range planning needs a soil survey operations management system is being designed. The system will list all soil survey areas in which soil mapping is expected to be completed in the next 10 years and those in various stages of completion. This system will permit more effective planning and scheduling of all steps leading to publication of soil surveys. It will also provide information needed to evaluate progress toward completion of field activities and publication, and pinpoint problem areas. It will indicate where adjustments are needed early to forestall major setbacks.

In some states, agencies urgently in need of soil surveys to assist in carrying out land use planning programs are now employing soil scientists. A large share of this effort contributes to the National Cooperative Soil Survey. Where needed, the training requirements of these soil scientists must be met to maintain the overall quality of soil surveys. Within the SCS many states are increasing their training efforts. A coordinated effort by all cooperators in meeting training needs can improve effectiveness.

*Director, Soil Survey Operations Division, Soil Conservation Service, USDA, Washington, D. C.

I would have liked to have bee” able to show you today a published copy of Soil Taxonomy. Although that is not quite possible, I can assure you that progress is being made and in the “ear future it will be published. The page proofs have been edited and are in the process of being returned to the printer. Although I cannot definitely say it will be out by February 14, as a happy valentine, it will be available soon. I'm sure all of you will be as happy as I will be when it is published. I recognize that its limited availability has presented many difficulties to our cooperators, Teaching of soil classification has been difficult. Publication of some bulletins and papers in scientific journals also has been difficult because of the lack of this reference source. Your patience and assistance with the publication of Soil Taxonomy is greatly appreciated.

Procedures have been developed and circulated for proposing, reviewing. approving and publishing changes to Soil Taxonomy. We welcome suggestions from all sources for improving the system. We recognize that much of Soil Taxonomy needs to be more fully tested. This can be done more readily when it is published and more widely available. Some suggestions have already been made, more are encouraged. Additional copies of the “Procedures for Amendments to Soil Taxonomy" are available on request to my office.

The SCS is developing a National Soils Handbook stating policy and procedures for the soil survey program, including land inventorying and monitoring, and cartography. The policy and procedures covered will affect both the SCS, and all others who cooperate in the National Cooperative Soil Survey. It is essential that all cooperators have the opportunity to contribute, review, and comment on the material in the handbook before it is issued. The SCS at all organizational levels is responsible for encouraging participation of cooperators.

The National Soils Handbook is intended to be separate and distinct fron the Soil Survey Manual. Some duplication may be necessary, however, until the revised Manual is published. The handbook will cover current policy and operational procedures much as the Soil Memoranda have done in the past. As the sections of the handbook are completed and issued, Soil Memoranda will be canceled. The handbook will be amended as policy or procedures change. We will brief you on the status of the revised Manual later today.

As I mentioned in opening, soil survey operations is in a period characterized by many changes, During this period, it is more essential than ever that good communications be actively encouraged among all participants of the National Cooperative Soil Survey. Occasionally, changes in procedures must be made quite rapidly. Good communications can contribute significantly to reducing or eliminating misunderstandings and difficulties. More states are becoming actively involved in soil surveys by financing or hiring directly soil scientists for field mapping. North Dakota, Maine, and South Carolina have enacted legislation for the registration of soil classifiers or soil scientists. More states will follow in the “ear future. As the rate of publication increases, the need for good coordination in all phases of the soil survey will also increase.

In the next several years, we in soil survey operations, will place increased emphasis on maintaining quality of soil surveys, long-range planning and management, training of soil scientists, and good communications between our cooperators.

Soil Survey Interpretations - A Look Ahead

-Lindo J. Bartelli*

Developing better soil surveys for Improving production and the environment is both a challenge and an opportunity for making more effective use of soil surveys. Our objective is to make soil maps more useful. We want to use a language that is well understood by the user. This is difficult, for the great variety of users require us to use many languages. In addition to text, we must use maps - simple soil interpretaion maps. We must use simple terms and stop confusing our users with the complex jargon of soil groups. We need to tell people what the soil is good for, we should be able to point to the good corn land or to the good cotton land. As Steinbrenner of Weyerhaeuser advertises, we need to knw the wood growing potential of every acre. Also, we must must be able to identify soil that is suitable for urban development and also recognize those measures required to make the site a pleasant and healthy place to live. Most important, the soil information must be provided in a timely manner. Our goal is to provide a published soil survey within 12 months after the field work is completed. Coordinated soil information should become available as the field work progresses.

The following objectives will guide the implementation of a more active soil survey interpretation program.

1. Adopt a more positive approach for presenting soil interpretations, including analysis of potential for given land uses.

2. Develop guidelines that can be used to predict the impact that various uses of soil, with improvements, will have on the environment.

To adopt a more positive approach for presenting soil behavior predictions we need to emphasize degree of suitability. These kinds of predictions allow for an array of mapping units on the basis of degree of suitability within the soil survey area. Soil potential is a means for expressing this comparison. It is defined as the ability of a soil to produce, yield or support a given structure or activity at a cost expressed in economic, social, or environmental units of value. Soil potential ratings presents a comparison of land-use alternatives in simple quantitative terms. The most suitable soils, e.g., soils with limitations easiest to overcome, will rate higher than soils with complex interacting limitations. When completed the system looks simple, but the process for rating is complex. It involves physical. economic and social considerations. The effects of interactions among the factors must be considered. The rating procedure requires a multi-discipline approach.

Director, Soil Survey Interpretations Division, Soil Conservation Service, Washington, D.C. 20250

The development of soil potentials is the first step in the evaluation of "land suitability." Soil potential analysis differs from an analysis of the land suitability for a particular use. The suitability of land involves, in addition to soil potential ratings, an assessment of location, distance to markets, market demands, transportation facilities and the skills of the tiller or developer. The array of soils on the basis of degree of suitability helps the decision maker seek the "best fit" between soil and use. The impact that a use has on the environment is governed, in many cases, by how good a fit occurs between use and soil. This does not necessarily mean that use should be restricted to what the soil is best suited for in its natural state, but rather, the use selected is based on the behavior after limitations are overcome. A prime example is the vast areas of poorly and somewhat poorly drained soils of the midwest that were considered worthless swamps in the initial land survey but now rate as prime corn land of the world.

We have formulated some provisional guidelines that will serve as a framework for developing soil potential ratings. They are:

1. Soil potential ratings are developed within the context of the soil mapping unit. They do not consider location, market trends or socio-political forces. Ratings can be developed for all kinds of soil maps. Potential ratings will reflect the soil taxonomic unit in detailed soil surveys, but, will be based on an evaluation of the interations among the soils in a multi-taxa mapping unit of the more general soil maps.

2. The rating for a soil will not be standardized, country wide. The same soil may have a different rating within two separate soil survey areas. Its position in order of degree of suitability is determined by the ratings of other soils in the area. Soil potential ratings for individual kinds of soil are in relation to all other soils in the area covered. Soil potential ratings, however, can be developed for any size area.

3. Supporting text is required to further define and explain the procedures used and to present the basic data upon which the evaluation is founded. Explain, also, the extent to which ratings reflect quantitative rather than qualitative data. Improvements for overcoming soil limitations are considered where feasible. This points out the need for collecting qualitative data on overcoming soil limitations and maintenance on improvements. Local information about "what works" in overcoming soil limitations must be recorded by kinds of soil.

4. Define clearly the land use classes. Soil potential should be developed for the broader land use classes. For example, a rating is more applicable to a soil's suitability for urbanization than for the various elements - dwellings, streets, shallow excavations, etc. - that are considered in arriving at the final rating. Soil, Potential for streets may have little meaning separate from the rating of potential for urbanization, especially where the streets only purpose is to support the urban development. There are cases, however, in which finer subclasses may be recognized, especially in farm related uses.

5. Identify the practices that might be used to overcome soil limitations. Also, include a general idea of their cost and an estimate of any continuing limitations after they are installed.

Pilot studies are developing models for formulating potential ratings and devising ADP techniques for presenting this information in graphic and tabular forms. The committee on organic soils, a committee of the southern work planning conference and several states are working on this problem. We hope to formalize procedures for collecting and documenting experiences on overcoming soil limitations in the near future. We will increase our application of soil potentials as we gain confidence through the data thus recorded about our experiences.

Soil potentials provde a valid basis for a positive approach to making land use decisions that will help insure the prudent use of the vast land resources of this country. A distinct change in philosophy is identified. We believe the prospect for continuing success in land use planning for soil resource development is much greater when the effort is centered around the positive objective of maximizing the net productivity of the land rather than around the objective of avoiding problems or nuisances.

As we gear our programs for the increasing needs of a public that is cognizant of land and its value, we turn our attention to more efficient and effective methods for delivering complex soil information. This is our challange. We must accurately predict the consequences of land use decisions in a more positive manner.

Soil Survey Investigations

Dr. Klaus W. Flach*

The properties of each kind of soil recognized by the National Cooperative Soil Survey have to be defined so that they can be identified uniquely and their potential for a great many uses accurately predicted. And, for efficient mapping and for the correct classification and interpretation of the many soils that have not been studied in detail, soil scientists must be able to predict from their knowledge of the effect of soil forming factors.

Most of the investigations needed to achieve these goals are being conducted by soil scientists in the field as part of operational soil surveys. Specialists in soil survey investigations at the soil survey laboratories and the soil-geomorphology teams at the Technical Service Centers and specialists in data management and climotology at the Washington office assist them with hardware and expertise.

Until recently the soil survey laboratories were concerned primarily with developing criteria for soil taxonomy and with providing the data needed for placing soils in the taxonomic system. Similarly, the soil geomorphology teams were concerned primarily with basic work on soil properties and processes of soil formation and their work was concentrated in areas where little basic information was available, such as upland desert areas, or in areas where old concepts needed to be reexamined, such as in the coastal plain of the southeastern states.

Now that Soil Taxonomy is completed and soil surveys are being used increasingly for a great variety of purposes, the emphasis in Soil Survey Investigations is shifting. The goal of "Better Soil Surveys for Improving Production and the Environment"--the theme of this conference--requires relevant quantitative information for kinds of soils and the interaction of soils and management systems. Particularly, we need hard data on the behavior of water in the soil landscape, the interaction of kinds of soils with fertility tests and crop response, and the interaction of kinds of soils and potential pollutants such as fertilizers, pesticides, or components of municipal, agricultural, or industrial wastes. We need this kind of information not only for areas with ongoing soil surveys but for areas with completed soil surveys as well. Hence, our efforts, more than in the past, will be concerned with the recorrelation, the reinterpretation, and the updating of old soil surveys.

*Director, Soil Survey Investigations Division, Soil Conservation Service, USDA, Washington, D. C.

In order to meet these new challenges we need a versatile and flexible staff, more specialization than we have had in the past, and more specific assistance to individual problem areas. Also, the soil survey investigations staff needs to make sure that we make full use of our own data and the data generated by our cooperators in states and in other federal agencies. Increasingly, the Soil Survey Investigations staff will be devoted to relating these findings to named kinds of soils.

At the same time we will need to continue work needed for soil classification, for the improvement of Soil Taxonomy, and for a better understanding of processes in soils that help us predict the occurrence and behavior of soils.

In order to meet these challenges we will be combining our present three small laboratories into one centrally located unit at Lincoln, Nebraska. This laboratory will be large enough to take full advantage of modern equipment and automated data processing methods, thus speeding up the flow of data to the field and releasing the staff for some of the tasks mentioned before. The laboratory in Beltsville will move during the summer of 1975; the Riverside laboratory during the summer of 1976. The timing of the move was largely controlled by the move of the laboratory at Lincoln to a new Federal Center.

Also, we will create soil survey investigations positions at the Technical Service Centers. These positions will be staffed by a geologist or a soil scientists with a strong background in geology, primarily in geomorphology. They will be working with party leaders and soil scientists at the state and TSC staffs on applied and basic problems of soil mapping, soil survey interpretations, and soil formation. They also will work closely with soil scientists at the soil survey laboratory who have responsibility for individual TSC's. These positions will, in part, be filled with staff members of the present soil-geomorphology teams.

In the area of data management we are improving the accessibility of our store of laboratory data through conventional publication in Soil Survey Investigations Reports and through automatic data processing. We have nearly completed the first set of Soil Survey Investigations Reports. Supplements to some of the earlier reports are being prepared. Some of the new reports and supplements will include data that had been generated by our cooperators at the Experiment Stations. They also will include the taxonomic placement of the pedons for which data were published in the previous SSIR for the state.

An automated "Index of Soil Laboratory 'Data" is ready for implementation. This indexing system provides an inventory and cross reference system for use with conventional filing systems.

The implementation of the pedon data subsystem--a fully computerized file of pedon descriptions and laboratory data--had been held up by the high cost of coding the pedon descriptions. We are hopeful that a second generation mark sense coding system will make it possible to code descriptions at a reasonable cost. A portion of our laboratory data already is in computer compatible form. The remainder will be entered through a universal program that can be used with a great variety of data sheets.

Finally, the ADP staff of the Soil Survey Investigations Division is developing a soil survey management system for use at the national, the TSC, and the state level that will be basic to the success of the accelerated publication program and project soil surveys.

LAND INVENTORY AND MONITORING

R. I. Dideriksen*

The Washington office Soil Survey Staff was reorganized in July 1973 to include a Land Inventory and Monitoring Division. The overall responsibility of the division is to plan, organize, coordinate, and give technical guidance to SCS inventory and monitoring programs including conservation needs.

Scope of SCS Efforts in Inventorying and Monitoring

There is marked increase in demand to provide data to users on (1) the kind, location and extent of soil, water, vegetation and related resources; (2) the potential of these resources for various uses; and (3) the changes and trends in the extent, use and condition of these resources. On-going and proposed programs of agencies, universities, and others reflect this need.

Some of the inventory programs that SCS is involved in are as follows:

1. Wind Erosion Conditions in the Great Plains States
2. River Basin Studies
3. Conservation Needs Inventory (CNI)
4. Recreation Inventory
5. Shoreline Erosion Study
6. Floodplain Mapping
7. Sedimentation Studies in 420 reservoir sites
8. Resource Plans
9. Special Inventories - conversion to cropland; estimating cropland
10. Others

The wide variety of SCS programs that use or generate resource inventories requires planning and coordination of activities carried out by the units, branches and divisions.

---

*Director, Land Inventory and Monitoring Division, Soil Conservation Service, USDA, Washington, D.C.

LIM Division Activities

No monies have been appropriated to implement a national land inventory and monitoring program. However, there are a number of items that needed staff attention. Some have been completed and others are under study and evaluation. These are mentioned primarily to inform non-SCS representatives attending this conference. The activities are as follows:

1. Identify USDA needs for data - Advisory LIM-4.

2. Provide definitions of and criteria and procedures for inventorying prime and unique farmlands, wetlands, flood-prone areas, and monitoring erosion and sedimentation - (Advisory LIM-12.

3. Make new cropland and erosion estimates for 1974 crop year - (Advisory LIM-11).

4. Revise wind erosion condition report to include soil and land use base data.

5. Identify and define land use and cover categories needed for USDA programs.

6. Provide guidance to states involved in developing resource information systems.

7. Assist in the development of USDA-Remote Sensing User Requirements Task Force catalog.

a. Evaluate the potential application of ADP terminals in SCS offices.

9. Correct and revise soil, MLRA, and watershed data on existing CNI files where needed.

10. Develop brochure on Conservation Data Bank on Rural Land and Small Watersheds.

11. Classify soils in midwest states by characteristics selected by EPA for their disease and insect control study.

12. Assist the Great Lakes Water Quality Board in the carrying out their study of land use activities for the U.S. side of the Great Lakes Basin.

13. Guide states in remote sensing activities.

14. Formulate an ADP procedure for SCS to utilize complete soil survey and other resource data.

15. Develop a procedure for updating the MLRA map for states and the U.S.

Since the conference time is limited, it is suggested that you contact the LIM Division for detailed information on items of interest.

We were hopeful that details of a national program and schedule for implementation could be presented at this conference. We cannot. However, when a program is implemented, it will differ in several respects from previous inventory programs. The most significant differences would be in the extent of the inventory and data source. Plans are to include all lands in the next inventory. Complete data, such as correlated soil survey, as well as sample data will be used.

The program planned for FY 1375 is tentative because allocations have not been announced for the USDA appropriations. As of now we plan to:

<u>Program for FY 1975</u>

1. Place a 3-man team at Reston to test and develop applications of advanced systems and technology for SCS programs.

2. Provide the procedure and tools to update the MLRA maps.

3. Pilot test proposed ADP procedure and point sample procedure. Templates will be developed for use in locating point samples and determining sample coordinates.

ORTHOPHOTOGRAPHY AND THE NATIONAL COOPERATIVE SOIL SURVEY

Jerome A. Gockowski

Director, Cartographic Division

Soil conservation Service

January 27, 1975

An aerial photograph is not a map nor can it ever be a map since the only point on the photograph that is accurate is the point directly below the airplane obtaining the imagery. Points on the ground that are below the datum plane are displaced toward the center of the photo and conversely those points which are above the datum plane are displaced away from the center of the photo. A pair of stereo-photographs, however, placed in a stereo plotter and differentially rectified with an ortho printer will result in a photographic image that is 8 map and is planimetrically correct, i.e. every point on the resulting photo image is in its correct position in relation to that point on the ground. This is an orthophotograph.

Orthophotographs are now offered in the national USGS topographic map series. The USGS Topographic Division obtains aerial photography for orthophotography at a scale of about 1:76,000. These high altitude photographs are quadrangle centered, that is a quadrangle is located in the center of each aerial photograph. USGS orthophoto quads are published in a 7-1/2 minute format at a 1:24,000 scale to coincide with their 1:24,000 topographic map series.

Orthophotographs are prepared by methods designed to meet national map accuracy standards. Various accuracy tests are performed to verify that 90% of the well-defined points tested are within 40 feet of true position - the horizontal accuracy standards for 1:24,000 scale topographic maps.

Orthophotographs portray an abundance of detail not found on conventional line maps and have the same positional accuracy requirement as standard topographic maps. Orthophoto quads are, therefore, useful interim map substitutes for unmapped areas and valuable complements to existing line maps.

Orthophotographs are in great demand for use as base maps by state and regional planners for landuse information, site selection for industries, utilities, public transportation, urban and suburban growth studies, and flood hazard, pollution and coastal wetland studies. Data. such as timber, soils, and crop inventories can be expeditiously plotted directly on the orthophoto quad and reliable determination of acreages can be made.

The orthophoto quad can be used to revise other maps or to serve as a base for making special-purpose maps. It is conceivable that, with the merits of the short production time and current information, orthophoto quad coverage of an area will serve as the basic source material for developing and maintaining digital data banks. There are numerous examples of the usefulness of the photo image base for hydrologic and geologic studies. Extensive flatlands, swamps, deserts, and coastal beaches are the types of the terrain least suited to line and symbol representation and oftentimes the most difficult and costly to gain access to for field work. Line maps of such areas appear grossly inadequate when compared with the wealth of information imaged in the orthophoto quads.

In 1968, the Cartographic Division investigated the possibility of using high-altitude photography for photo base sheet preparation. Since 1970, we have obtained high-altitude aerial photography for approximately 3/4 of all the soil survey areas that are published annually. The criteria is that high-altitude aerial photography may be rectified for photobase sheet preparation where the difference in elevation is less than 300 feet within a two mile radius of any one point. However. we are rewired to mosaic those areas that have excessive differences in relief primarily in the western and eastern states.

Today's cost of obtaining photo base sheet negatives by mosaicking an area is approximately $13 to $16 per square mile, compared to $9 per square mile for obtaining photobase sheet negatives from 1:48,000 high-altitude photography. The SCS cost for preparing photo base sheet negatives from orthophoto quads is averaging $13 per square mile.

In August 1973, we developed a cooperative cost-sharing agreement with the USGS for the preparation of orthophoto base sheets. Since the USGS 1:24,000 series of quadrangles do not follow county lines, soil survey areas will occupy portions of orthophoto quads. Consequently, we agreed that we would cost-share on all orthophoto quads required to cover a soil survey area. The total cost-shared area is 25% to 30% greater then the required soil survey area. However, we can use the additional imagery and orthophotography for regular conservation operations. This arrangement provides SCS with a high priority for USGS completion of the orthophotos. Orthophotos can be used for publication scales of 1:20,000 and smaller.

The Topographic Division, USGS prefers to fly only in the spring during leaf-off, snow-free condition. Approximately 18 to 24 months are required to satisfactorily complete a contract. If weather conditions preclude flying in the spring, the contract is held over another year. Consequently, the timing for submitting requests to USGS for orthophotography is critical since a minimum of three months is required for planning and awarding contracts.

At the present time, we have contracted for a total of 1.696 quadrangles with the Topographic Division, USGS, at a total cost of $808,835. This includes one area each in FY 1972 and 1973 and 52 areas in calendar year 1974. We anticipate contracting for about 40 additional areas this calendar year, for the FY 1978 publication schedule.

The total cost of producing an orthophoto quad, including ground control and orthoscope scanning, is averaging $800. With the cost-share arrangement, an orthophoto quad is obtained from USGS for approximately $400 or $7.50 per square mile, thereby placing it in a competitive position with mosaicking and high-altitude imagery for photobase sheet preparation. Most important, orthophotos provide a planimetrically correct base on which the soil survey data are recorded. This base will fit accurately the mapping programs of other mapping and planning agencies using the 1:24:000 USGS series of base maps.

Orthophoto quads are prepared by the USGS in a 7-1/2 minute format, that is, approximately 18" wide by 23" high dependent on Latitude. The Soil Conservation Service has published 3 areas with soil maps in this format. The maps were folded and placed into jackets that accompanied the published soil surveys. The additional cost per soil survey book using this format was about $3.00 per copy. Consequently, we have divided the 7-1/2 minute sheets into three 2-1/2 minute x 7-l/2 minute sheets and bind these into the published soil survey. These one-third quads will register accurately with the 1:24,000 USGS series bases that are used by the planners and others, and are bound into the published soil survey for better utility at less cost.

Several factors must be considered in using orthophotography for mapping of soil surveys. First, one cannot satisfactorily do any stereoscopic viewing with orthophotographs. Consequently, mono- photo interpretation has to be done from the orthophotograph itself. Second, in the orthophotographic process image resolution is reduced as much as 50% when compared to an enlargement from the original negative to the same scale.

Several alternatives present themselves for utilizing orthophotography for soil survey mapping in the field. The first alternative is to obtain the 2-1/2 minute x 7-1/2 minute orthophotographic base sheets through cartographic and map directly on these, but use 1:48,000 scale enlargements of the original photograph for stereo viewing. The soil scientist must be able to relate features that he sees stereoscopically at a 1:48,000 scale to the 1:20,000 or 1:24,000 scale at which he is mapping. The second alternative is to obtain quartered enlargements to publication scale from the original negative. Field mapping can be completed on each sheet. It will measure approximately 18" x 18" and is easy to handle in the field. After the data are mapped in the field, they would be transferred to the overlay registered to the 2-1/2 minute x 7-1/2 minute orthophotograph and inked using the new planning procedure. This provides the field staff with the advantage of using stereoscopes for photo interpretation prior to and during field mapping. This is the highest resolution product for mapping. The orthophoto provides an excellent base for the soil survey publication program.

In preparing the quarters from an individual negative, an approximate overlap of 2 inches at the center of the photograph is provided. These quarters are made on 18" x 18" paper at a present cost of $5.00 per print. Stereo coverage for each quadrangle requires two full prints, quartered, with a resultant cost of about $1.00 per square mile for the survey area. The 1:48,000 enlargement of the original negative results in a 15" size print which also costs $5.00 per print, or about 20¢ per square mile.

If orthophotography is ordered for mapping in the field, it would be desirable to obtain enlargements from the original negative for field mapping. Field work can proceed before the orthophotographs are obtained. Continual adjustment of photo images for registration will be required when transferring soil delineations to the orthophoto.

In summary, using the orthophotograph as a base for soil surveys:

- Brings our soil surveys into the map user community where the standard format meeting national map accuracy is used by planners and other federal and state agencies.

- An accuracy is provided for soil data management files that will fit the map bases of other agencies using these standards.

- An accurate photobase is provided in areas of difficult terrain where mosaicking at best is difficult and results in less than a completely satisfactory product.

- Orthophotography provides another tool to improve the quality and the use of the published soil survey and, at the same time, reduces SCS cost and manpower requirements.

STATUS OF THE REVISED SOIL SURVEY MANUAL

Morris E. Austin*

Progress on the revision of the Soil Survey Manual has been slower than hoped for. Demands related to completion of Soil Taxonomy, organizing and implementing the new procedures for publishing soil surveys, and work on the National Soils Handbook on the time and talents of members of the senior Washington staff and the staffs of the 'principal correlators have not permitted them to give this project the attention warranted by its importance. Furthermore, Marlin Cline, who provided much of the leadership and did a major part of the work on the Revised Manual retired in June of 1974 and no longer contributes to the effort. Hence, the target date for publication in fiscal 1975 will not be met.

The response to the four drafts by reviewers has been disappointing. On the average we have had responses from about 20 percent of the mailing list. Our most faithful reviewer has been Dr. Kellogg, who has critiqued each draft and sent us large numbers of suggestions. For the most part his suggestions have been useful, though some were not accepted.

The practice that we followed for each draft was to transfer the comments from each reviewer to a clean copy of the draft. These ware then evaluated and used insofar as possible in preparing the following draft. Needless to say we received conflicting viewpoints on many points and had to arrive at a judgment on the basis of our own understanding and prejudices as to which ones to accept. Usually we sought counsel from available collegues on the more controversial items. Both Dr. Cline and I reviewed the third draft and the fourth draft resulted from this collaborative effort.

At a staff meeting of the Washington staff and the principal soil correlators in Washington, in early December at the urging of Mr. Johnson, a revised schedule for completion of the Manual was agreed upon. These plans represent the concensus of the participants, though for some items the agreement was not unanimous. A summary of the proposed procedure and schedule follows:

A. The Revised Manual will retain the general character of the Agricultural Handbook 18, published in 1951. It will serve as a "How-to-do-it" textbook for universal application in making soil surveys everywhere.

B. The Manual will retain the organization of the fourth draft of the revision without major reorganization, though some rearrangement and revision within the chapters may be required.

C. Material of a transitory nature, such as that in various Soils Memoranda, procedures for day-to-day operations, and matters of policy will be deleted from the current draft of the Manual and placed in the National Soils Handbook now in the process of preparation.

*Soil Scientist, Soil Conservation Service, USDA, Hyattsville, Maryland; read by V. G. Link

D. Responsibility for review of the current drafts rests with the division directors of the Washington staff and the principal soil correlators. It was agreed that the responsible individuals were free to seek advice from interested ARS Cooperators and others as needed. Responsibility for the reviews were assigned as follows:

Chapter	Director with Major Responsibilities	Principal Correlator Major Responsibility	Principal Correlator Secondary
1	Operations		
2	Operations	South	All
3	Operations	Midwest	
4	Operations	West	All
5	Operations	West	All
6	Operations	South	All
7	Operations	Midwest	
8	Investigations	Northeast	
9	Investigations	Northeast	
10	Operations	Midwest	
11	Interpretations		All
12	Interpretations		All
Appendices I	Operations		All
II	Operations		All
III	Operations		All
IV	Operations		All
V	Investigations		All
VI	Investigations		All
VII	Investigations		All
Literature Cited	Operations		
Index	Operations		All

E. The time schedule for the work to be completed was set as follows:

1. Work on revision of the text and necessary deletions of material to be transferred to the National Soils Handbook is to be completed by April 1, 1975.

   a. The principal soil correlators are to send revised material to the director concerned and also a copy to the Hyattsville office of the Soil Survey Operations Division for the complete file on the Manual.

   b. Principal soil correlators send copies of their material to all other principal soil correlators, and consult by telephone or correspondence as needed.

2. A member of the Soil Survey Operations staff at Hyattsville is to be responsible for coordinating the contributions from the various sources, as received.

3. One hundred copies of the complete revised draft are to be prepared by May 1, 1975.

4. This draft is to be tested by field staffs and reviewed by others as listed in "F" below by October 1, 1975.

   a. State soil scientists consolidate comments from within their state and forward them to the principal soil correlator responsible for the work in their state. The principal soil correlator will then consolidate the responses from their group of states and forward them to the appropriate director and Hyattsville as specified in 1.a. above.

5. A final revised text is to be prepared on the basis of responses to tests and reviews beginning January 1, 1976.

6. Final revised manuscript to be reviewed by principal soil correlators and senior staff April 1976.

7. The manuscript to be sent for edit June 1, 1976.

a. Revised Manual published November 1976. Jack McClelland mentioned the possibility of Soil Taxonomy as a Happy Valentine this year. Possibly you can put the Revised Manual on your 1976 Christmas list.

F. Copies of the May 1 draft for testing and review are to be distributed as follows:

1. Principal correlators--4 each

2. Washington staff directors--2 each

3. State offices--3 each for the listed 18 states which were selected to obtain a cross section of the Land Resource Regions. The Deputy Administrator for Soil Survey will alert the state conservationists in the listed states to the need for testing of the draft Manual.

Alaska	Maine	Oregon
Alabama	Minnesota	South Dakota
California	Montana	Tennessee
Florida	New York	Texas
Hawaii	North Carolina	Utah
Illinois	Oklahoma	Virginia

4. Chairman, Land Grant Regional Soil Survey Work Groups--l each. They may arrange such review as they deem appropriate and forward comments to the appropriate directors and Hyattsville to meet the deadlines set above.

G. I have some specific suggestions for reviewers as follows:

1. Because the National Soils Handbook will be issued before the Manual is published, some overlap between the two will be unavoidable. Some items of general or universal application will be first issued in the Handbook. When the Manual is issued, the parallel sections of the Handbook can be canceled and reference made to the appropriate part of the Manual.

2. Remember that the material in the Manual was synthesized from knowledge gained by many people working in soil survey over many years. It reflects many years of experience in teaching, making and interpreting soil surveys by Dr. Cline himself. He also sought counsel from many others and used many of their ideas. The fourth draft reflects the concensus of many people. Let's not change it to conform to some passing fad or fancy.

NACD and the Soil Survey Program

George R. Bagley *

Soil Surveys seem to be the universal language. You Soil Scientists are universally appreciated, I can assure you. To have been here all week must have been like a worldwide tour. in your associations with one another and with those here from other countries. I know of no better way to re-assess the future prospects for food and living standards for the world than to combine your collective abilities, ingenuities and creative thoughts based upon sound knowledge, going beyond where research has even gone in determining potentialities of the soil which sustains us.

The limitations of our basic soils may be the very proverbial grain of sand in the oyster that irritates and eventually creates the pearl. If your job was easy it would not be nearly so challenging.

With the problems facing the world you have a real complicated crazy quilt pattern to piece together. I'm sure you have made considerable progress in bringing the pieces together this week. I commend you for your efforts, and your very worthwhile committee reports and for your thoughtful discussions, and for bringing together outstanding individuals representing much knowledge and experience.

David Bright, in A Dec. 9, 1974, Bangor (Maine) Daily News editorial had a salute to the soils men which you should share. In this world of communications it is good when the activities of "soils men" reach the news and excellent when they are saluted in the news.

The Bangor Daily News Editorial

A Salute to the Soils Men

"Two of the lesser known state organizations held a joint annual meeting in Brewer Dec. 5 and 6. And it is ironic that while they are relatively unknown to the vast majority of Maine people, these two groups are probably two of the most important organizations in the state of Maine.

"They are the Maine Association of Soil and Water Conservation Districts and the Maine Soil and Water Conservation Commission. They are composed of the farmers, and owners of open space land, and woodlot operators and soil scientists who make up the backbone of the great agricultural state of Maine.

"Long before it became popular or profitable to be "concerned" about our environment, they were there in the field, fighting soil erosion, working to maintain water quality standards, and opposing development--be it commercial or esidential--which was not in harmony with the natural elements of the area.

*President, National Association of Conservation Districts

"It was the soils people who discovered that Aroostook potato farmers were literally losing truckloads of topsoil from their fields each year due to sloppy farming practices, practices which gave the farmer short-term gains but pointed to long-term disaster as the fertile soils of Aroostook gradually eroded away.

"Now any fanner worth his spuds practices crop rotation, builds diversions and other drainage control measures, and is careful about protecting his most valuable property, his soil.

"It was the soils people who first brought to public attention the fact that improperly constructed septic systems were slowly poisoning those who drank from nearby wells; that unless proper soils were built on, even the best-made foundation would soon crack and crumble, and that where a farmer was wasting his time and money trying to grow a marginal crop, a different crop on the same ground would produce a healthy yield.

"Anyone planning to buy a lot, build a house, or attempt to earn his money from the land who doesn't first consult one of the soils people is foolish.

"For the soils people, working in close cooperation with the U.S. Department of Agriculture and related state agencies, can help make the project a success, or can spot dangers to success hidden beneath the ground that the layman will never see.

"Best of all, the services are free to any landowner, and these days that's a hard offer to beat. So we congratulate the soils people for the accomplishments they've made in the past."

All over the nation Soil Conservation District Newsletters recognize your importance. The January 1975 Wapello County, Iowa, Soil Conservation District Newsletter entitled "Soil & America's Future--Wise Land Use Vital to Life" says:

"Soil has different meanings to different people. To the homemaker it is something which she battles daily to maintain a tidy house; to the engineer it is material to build a dam or highway; to the sub-division planner it is something to build houses on and put septic tanks and sewage disposal fields in.

"To the forester it is something to grow trees in to produce paper and cellulose; to the farmer it is the substance to plant seeds in to grow crops and grass for food and fiber; to knowledgeable people it is the base of our existence.

"The basic principle of good land use the world over is using soils for the purpose they are best suited for. Soil scientists tell us that in the United States today we are using 40 to 50 million acres to produce crops that will not, under any known agricultural practices, produce a good return. On the other hand, they tell us we have approximately 200 million acres suitable for crop production now in grass, brush, and trees.

"Soil scientists have identified tens of thousands of different kinds of soil. Most soils consist of two or three distinct layers. The physical and chemical properties of each of the layers and the great number of combinations of properties explain why there are so many kinds of soil. In Wapello County there are 80 different kinds.

"There is enormous variation in the use capability of soils. There are many different kinds of soil. When it comes to putting soils to use suited to capability, we apparently have ***not*** done too well. Better knowledge of soils is the starting point for strengthening the economy and raising the living standards."

So the attention of the public is directed to the land and its value as never before in our history. The increasing need for land for production of food and fiber is apparent as rising food prices affect everyone. Water quality and other environmental issues are items of interest and concern to an increasing proportion of our people. Increased demands for land for surface mining impinges on both issues. At no prior time have all factors pointed more clearly, or more urgently, to the need for use without abuse--for full restoration of environmental values and productive potential after harvest for our immediate needs.

I don't need to remind you gentlemen, of all people, that the soil is the basic resource that sustains both the productive capacity and the environmental values of our land. It has been my good fortune to travel to many parts of our great country, including Alaska, Hawaii, Puerto Rico and the Virgin Islands, Europe, Russia, Canada, and Mexico in the last few years. I am pleased to report that the use of natural resource inventories, especially soil surveys, in reaching sound land use decisions is receiving top priority with many of the individual districts and state associations and many areas with whom I have visited. Where surveys have not yet been started, the districts are in the forefront in making the necessary arrangements for their initiation. Where surveys are in progress or completed, the districts are playing a leading role in urging that the data assembled be applied fully in land use and management decisions.

There is one simple, yet over-powering reason for the interest of the districts in soil surveys--our convictions that valid decisions about resource use cannot be made unless it is possible to accurately predict the consequences of these decisions. Such predictions are required both for outlining viable alternatives and for deciding among them. Soil surveys provide data for definitive evaluations of the environmental impacts of proposed land use changes. They also provide data for evaluating the economic impacts of such proposed changes.

We are pleased to note the recent discussion of practices to overcome soil limitations for non-farm uses. This is really the same thing as has always been done in conservation planning on the farm when drainage or erosion control practices are identified. But the important point is that it's not possible to identify alternatives in land use unless these practices are identified and judgements made about their feasibility. Across the country, our communities are faced with difficult land use decisions. They need the facts necessary to predict the consequences of alternative actions, and many of these facts must and will be supplied by properly interpreted soil surveys.

The need for this data extends across all kinds of land use. Recently I learned about the intensive forest management program, based on soil surveys, of a large wood products corporation. This program was based on extensive data which related tree growth to kinds of soils and management practices. Similar data identified the fact that 51 percent of the soils now in woodland in and RC&D project area in southeastern Oklahoma would yield net returns of less than $2.00 per acre par year even under good woodland management. This information clarifies the contribution of woodland management on these soils to the economic growth in the area, and helps in the identification of another set of practices that will make the greatest contribution to the area at the lowest cost.

The new procedures for accelerating soil survey publications seem to hold great promise for overcoming a vexing problem, and we wish you complete and early success with them. We can assure you that the districts will be eager to help in the effective distribution and use of the new soil surveys.

Each year the Policy Positions of our National Association of Conservation Districts are refined or changed or new policy is made by the NACD Council. The Council members of the 50 states and Puerto Rico and the Virgin Islands are charged with policy decisions to carry out the objectives of conservation, development and self-government. Our NACD Council will meet this coming week in Denver with delegates from the 3000 Conservation Districts. This is much the same as your meeting here. You are here from the soil survey staffs of the Soil Conservation Service at the Washington office, service center, and state levels, with other federal and state agencies cooperating in the soil survey, as well as representatives of the soil survey of other countries. You are here at this conference to improve the technical quality of the national soil survey program. You have identified and discussed the needs and the problems of the soil survey program. This is a very useful and vital conference to your entire soil survey staff throughout the entire National Cooperative Soil Survey.

What you have discussed this week will be of the utmost importance to those of us facing land use decisions of the greatest magnitude today. Your soil survey program gives us the only authentic scientific basis upon which to build a program of conservation of our natural resources. A cathedral is more than a pile of bricks. You provide the very foundation of knowledge and factural data upon which we build. Without such data our cathedral of tomorrow cannot be started. When we run out of the spirit of cooperation between countries, agencies and organizations and individuals--the very cohesiveness of this group--we have run out of mortar. when we run out of mortar we are through. Our cathedral of tomorrow will be built with your help as we plan for and achieve a more workable world, a more productive society, a more precious resource base being used according to its capabilities and considering its limitations.

I want to convey to you and your associates our sincere interest in your soil survey program. I want to assure you of our support and cooperation. Our 17,000 District officials, our 3000 local conservation districts, our 52 state associations and our National Association of Conservation Districts appreciate what you are doing and stand ready to help in any way we can. You see, there is method in our helpfulness, for you are the only ones who can help us in this problem of land use planning.

We're counting on you to lead the way down new untrodden paths as you seek new and innovative methods. We don't want to get off on a cow path as described by the poet Sam Foss:

> "A hundred thousand men were led
> By one calf near three centuries dead.
> They followed still his crooked way,
> And lost one hundred years a day;
> For thus such reverence is lent
> To well established precedent."

We think it is a find forward step to see you place Soil Scientists in the State Planning Offices as you have done in Louisiana. Do you think NACD should support the state registration of Soil Scientists? If you do, the way to approach this matter is by seeking out a knowledgeable NACD Council Member and have him introduce an appropriate resolution on the floor of the NACD Council next week.

Does NACD support the acceleration of soil surveys as a basic need for a national land use policy and for evaluating and planning major land use changes? (Such as the surface mining operations?) "Definitely yes!" is the answer. We urge the completion of Soil Surveys by 1985.

Our official 1974 Policy Position on Soil Surveys is this:

"Accurate soil surveys, properly interpreted, are needed to provide the facts required for all types of land-use planning, including not only agricultural and watershed uses but metropolitan development.

"Planning and zoning authorities need this basic data to help prevent the misuse of land and to help regulate development in a planned and orderly way.

"The facts derived from interpretive soil surveys can be used to promote conservation of natural resources and help sustain the ecological balance in our environment.

"At present, however, soil surveys are available for only a portion of the nation and do not cover many areas of current or projected development where they are most needed. Also, many of the older published surveys do not contain the nonagricultural interpretations so useful in areas of current development.

"In view of these circumstances the NACD urges that:

1. Soil surveys, properly interpreted. be completed and published in a more efficient and rapid manner than is now the case,

2. Such surveys include all major factors relevant to all types of land use, and areas of current or projected development be given priority in such a program,

3. Older published surveys, not containing nonagricultural interpretations, be revised and updated to include such interpretations,

4. All land included in conservation districts, with specific attention to areas of nonagricultural development, be covered by such surveys within the next three years,

5. These surveys be eventually extended to include all privately owned lands not included in present conservation districts, even if this requires the formation of new districts,

6. Areas willing to help themselves by contributing funds toward the completion and publication of these surveys should be given priority in this program, and

7. To accomplish this program, the Soil Conservation Service, USDA, should begin at the earliest possible time to employ and train additional soil scientists."

One of our charges is to help increase food production in the agricultural regions of the country, and gain this increased production without damage to the land. The Soil Conservation Service has already pointed out the potential hazards of an accelerating erosion problem, and this is another piece of the "all-out" production quilt.

We need your help, and I mean this sincerely, to back the efforts underway to preserve prime agricultural land, wherever the danger of conversion to nonagricultural use exists. These lands, so important to the future of our nation and possibly to the world, likewise need our support to protect them from damage by overuse.

Nathaniel Hawthorne in The Scarlet Letter said: "Human nature will not flourish, any more than a potato, if it be planted and replanted, for too long a series of generations in the same worn-out soil."

Our prime agricultural lands in America are the same lands that might be "prime" residential or the "best" industrial sites, the "finest' transportation corridor, or these lands might be stretched out over oil or a mineral in critical demand. The conservation of prime agricultural lands will be the biggest fight you have and will result in your greatest accomplishment in the annals of history. And, if you in USDA don't fight to identify and preserve these prime agricultural lands, who will?

Conservation districts need to move ahead with the basic work of land inventories, soil surveys and land use planning. The proper allocation of resources and the determination of a quality environment will be difficult without these basic inputs. Did I say difficult? They often will seam impossible! Soil and water conservationists must deliberate issues that stem from assessing the capability of a given land area. We know well the value of a soil survey and of planning land applications through a systematic approach. We appreciate the skill that goes into a farm plan. It results in an environment we like. We need to expand this basic appreciation and experience to institute the same procedure of comprehensive land use planning on the broadest possible scale until it encompasses what is best for the land and best for the people district by district until we cover the earth.

Because of the increasing demands for soils data for such a wide range of planning and development uses in rural as well as metropolitan areas, we recommend in NACD increased appropriations to the SCS for soil surveys in amounts that will provide for the orderly completion of the National Cooperative Soil Survey by 1985 or shortly thereafter.

We also favor increased funding for soil survey work by public land administering agencies.

We recognize that significant conservation accomplishments have been made possible through appropriations provided by the state legislatures of the nation. Both urban and rural populations have benefited by the accelerated conservation. Real estate values and agricultural production have increased because of it. The public interest has been served admirably through the state funds which have been provided.

NACD commends the legislatures of the states, Puerto Rico and the Virgin Islands for their appropriations in support of soil and conservation work. We urge increased state funding.

It would be misleading the public for NACD and districts to obtain additional authorities and responsibilities if a corresponding effort was not made that matched the manpower to the job.

My Tuesday Letter of ten days ago showed a table of state and local funds appropriated for the state soil and water conservation agencies and state and local funds provided for direct assistance to conservation districts.

State funds for conservation district programs continued at their record high of $47 million this year. Appropriations are climbing. A new survey shows that $47 million in state funds and $39 million in local funds--principally from county governments--were allocated for district-related programs in fiscal year 1975.

For soil surveys there were state funds appropriated of $4,083,998. Appropriated for soil surveys there were from local funds $2,458,379. This information was collected by the Soil Conservation Service in accordance with a new procedure developed cooperatively with the Association of State Soil Conservation Administrative Officers and NACD. It is the first time that comprehensive data on local contributions has been collected in this manner, and subsequent annual surveys should provide a good record of local and state support of district work. This is another example of the increased three-pronged attack SCS, NACD and Administrative Officers are collaborating on and the strength of a three-way team is being felt.

Another example of local, state and federal cooperation is the way you have managed to get a soil scientist into the State Planning Office. This is excellent.

In 1964 when I visited Europe and Russia, I felt that we were falling behind in the USA. I hope we are spurting ahead now in the matter of soil surveys. In Hungary, The Institute for Soil Science had 156 trained Ph.D.'s who were soil scientists meeting the challenge of mapping their entire country with the goal for completion by 1970. The books and literature they gave me were in a foreign language and were about as easy to figure out as your excellent committee reports are for a layman.

A campaign has been on around our house ever since a copy of your Soil Surveys and Land Use Planning arrived sometime after 1966 when it was published by the Soil Science Society of America and the American Society of Agronomy and edited by Messrs. Bartelli, Klingebiel, Baird and Heddleson. For the layman and especially for women who understand the traffic-light syndrome my wife thinks the greatest soils information is imparted by your simplified color coding. Where there are severe limitations the red color says STOP. Where there are moderate limitations for a specific purpose the yellow color means CAUTION. Where there are none or slight limitations for the particular "se the green light means GO. Her prize possessions are large maps of our farmland and developmental property done this way showing suitability interpretations for septic tanks, sewage lagoons, homesites, airports, golf courses, picnic tables, agricultural land, etc.

Your work is very valuable.

As a group of people interested in completing the soil survey of the United States and Caribbean Area, we all should be pooling our know-how in order to complete this job as soon as possible. Soil survey information is needed on all land now. And we definitely are encouraging state associations of conservation districts to use their influence and persuasion in securing state funds for the hiring of soil scientists. Many states and even cities are now furnishing funds for soil survey staffs.

Essential to surface mining reclamation is the soil scientist.

Essential to land use planning is the soil scientist.

Essential to regional planning is the soil scientist.

Essential to farming in times of high costs is the soil scientist.

Essential this year with fertilizer high costs and scarcity of materials is the sampling of each field.

I was in Wyoming last month with Mel Davis at their state association meeting. He enumerated many uses for the soil survey.

"One important base for land use and treatment decisionmaking is the soil survey... The demand for soils information by units of government for taxation, land-use planning, and individual site development continues to increase dramatically...One very current use of soils and other technical information is in reclaiming land from which mineral resources are being harvested to meet America's high priority energy needs... There is no reason why surface-mined lands cannot be assets instead of liabilities."

There is much that we can do together in SCS and NACD and in cooperation with other agencies. I think Ken Grant and I signed a really significant Memorandum of Understanding when I was in Washington ten days ago. The Memorandum of Understanding between the Bureau of Land Management, Forest Service, and NACD to coordinate resource planning was and is a big step forward in preventing duplication of efforts and the use of many resources of these agencies to progress in resource management and planning.

Thank you Ken Grant and Bill Johnson for inviting me to your meeting here in Orlando. The city must have been named for the character in Shakespeare's _As You Like It_, for I certainly find it as I like it.

Soil Surveys For Use After Use

Kenneth E. Grant*

I'm pleased to participate in your work-planning conference for the National Cooperative Soil Survey. It's obvious from the number of you who represent other Federal agencies and the agriculture experiment stations that this is a cooperative venture. It is because of our close working relationships that we have as much of the country mapped as we do, that we have as much information compiled to go along with the maps, and that we have such good success in reaching people who need this kind of information.

Cooperation with other nations has added significantly to the body of soils knowledge and the development of a taxonomy for soil science, and experiences in the United States have helped other nations gear up their own soil survey efforts. I hope this give-and-take will be strengthened by having several people from other nations at this meeting, and by continuing cooperation in the future.

We want to strengthen all our efforts because we need to increase the production and usefulness of soil surveys. They must be available to meet growing and changing demands from national, state, regional, and local levels of government as well as individuals. I hope at this conference we can share strengths and shortcomings and make the soil survey program move ahead in a way that provides better facts sooner--and in a more useable format--to more of the people who can benefit from them.

A good example of national and international cooperation is the major publication effort. Soil Taxonomy. It takes more time than anyone would like to get such a massive work through the printing process and the mails; but we have sent copies of the definitive text to cooperating groups, and the official publication should follow shortly.

While the extensive documentation required for this hook has been done under Washington Office supervision in SCS, many of the ideas originated in the field and in other countries. Most definitions have been tested using field procedures. For the contributions each of you may have made, we are most appreciative.

Soil Taxonomy will not remain static. Procedures for its continuing development have been distributed. If it is to have universal application, we surely will need the continued cooperation of soil scientists in all parts of the world.

*Administrator, Soil Conservation Service, USDA, Washington, D. C.

The Soil Survey Manual, an outline of soil survey procedures followed in many countries, is being revised and updated. The procedures it contains have changed somewhat with advances in technology and equipment. We have provided review copies to cooperators and have received many useful suggestions. The revised text also reflects some of the ideas developed at past work-planning conferences like this. I hope that by the time you meet again, the new Manual will be in your hands.

We're also compiling a National Soils Handbook, Much of the content of this looseleaf publication will be an updated form of the policies and procedures in the SCS Soils Memorandum series.

These publications, as well as the discussions here and at state-wide soil survey work-planning conferences, are aimed at keeping policies and procedures up to date to ensure that soil surveys are meeting the needs of all users. But handbooks and conferences aren't enough. We all need to review our priorities and goals continuously to make sure we are going in the right direction at the right speed. I am certain that, through cooperation, we can improve the rate of progress and the quality of our soil surveys.

Inter-agency cooperation will be important. Much of the supporting chemical and physical data for our soils are provided by such cooperators as the Agricultural Experiment stations. And, of course, nearly all SCS people in soil survey work received their academic training at state colleges and universities.

We are re-directing part of the SCS efforts in soil survey investigations toward getting more useable facts for soil surveys and returning data to the field more rapidly. We plan to give higher priority to studying ways to predict soil behavior for more kinds of soil and for more kinds of uses. We have de-emphasized somewhat the work in soil genesis and classification.

In order to meet these objectives, we are consolidating the soil survey laboratories into one laboratory in Lincoln, Nebraska. This laboratory will be staffed and equipped to attack a greater variety of problems, and to return information to the field in a matter of weeks and months rather than years. Through the use of modern equipment integrated with automatic data processing equipment, the laboratory will be able to handle great numbers of samples efficiently. The new laboratory will be working closely with the Soil Mechanics Laboratory and will provide services to other SCS programs.

Also, we are reorganizing our soil-geomorphology teams to give closer assistance to the field. We're phasing out one of the teams in the South region and reassigning that staff work in several areas of the West--for example, the Fort Union coal-deposit area in the Dakotas and Montana and Wyoming. In such areas, soil survey facts are badly needed to insure that large-scale land-disturbance plans are blended with proper attention to minimizing environmental damages and maximizing later land uses.

As another aid to data collection, we are establishing a three-man multi-disciplinary team at the U.S. Geological Survey facility in Reston, Virginia. This team will plan. design, and test advanced systems for resource data collection, analysis, and display. They will evaluate classified technology, imagery from the Earth Resources Technology satellites, and other tools for their possible application to SCS programs. The team's findings will be useful around the Nation.

We are moving along well in the effort to place all soils interpretations into computer storage for easy recall for published soil surveys and for other uses. Completion of the soil interpretation record--the SCS-Soils-5 form--for all active soil series is an essential element in our plans for an automated file. We've received the forms for about 4,500 series thus far. From them, we have compiled about 50 sets of tables for soil survey manuscripts. Use of the computerized tables from data stored on the SCS-5 forms will save a great deal of effort in the field. It also will assure that interpretations are coordinated between states and eliminate much of the review and editing necessary under present procedures.

We are also in the process of putting into computer storage, at Iowa State University, basic--or "hard"--data on the relationship between soil types and the growth of trees:

--The tree species most suitable for planting;
--trees that should be favored in an existing stand;
--soil-site index; and
--the likelihood of management problems such as erosion hazard, equipment problems. seedling mortality, windthrow hazard, and plant competition.

We'll be able to manipulate the stored data and retrieve them in any of several formats--leaflets or soil-interpretation records about individual soil series, camera-ready printouts of tables for published soil surveys, and new compilations that will extend the knowledge of specific soils to include whole groups.

Right now, we have put into computer storage the soil-woodland information for more than 30 percent of the soil series in the United States. We plan to have this information for nearly all of the series stored by the end of 1975.

There must be something to the correlation between soil types and tree growth. In several television commercials, Weyerhaeuser has put real emphasis on the use of soils information in growing trees. This major timber-producing firm slso has a contract to do soil surveys on a million acres in Oregon, at a cost of about $.75 an acre. The firm wants SCS to correlate the surveys.

Other Alternatives for accelerating the publication of soil surveys have been evaluated very thoroughly since your last meeting in 1973, and we are optimistic that the new procedures recommended by the Task Force will succeed. We intend to give our fullest possible support to these procedures. As the details for implementation are worked out, I ask each of you to give your full measure of constructive ingenuity to this effort.

The use of word-processing machines to generate explanations of tables and other portions of soil survey texts also will help reduce time and effort in publishing soil surveys. All these sections can be written, edited, and stored on tape cassettes for direct insertion into texts. With the new text outline, a higher proportion of the text is in the form of pre-written materials--or "modular writing". This saves writing, typing, and editing time, since some sections or parts of sections can be used over and over, just changing enough words to make the material fit the survey area.

At our soil survey editing branch in Hyattsville, Maryland, a few weeks ago, we went through the modular-writing process to blend several tapes of computerized data into one master tape for a soil survey manuscript. Procedures for marking the copy for printing instructions also have been programmed. The staff then took the tape to the Government Printing Office, where it was placed in a new computerized typesetting machine. In about 20 seconds, the machine ran through the equivalent of 40 pages of manuscript.

This means that as this process moves along, we can set a manuscript into type in minutes that used to take weeks to set. The editing staff, along with all of the field offices and technical service centers that produce the raw material, already have cut editing costs almost in half. These savings will help tremendously, because printing costs have soared and will go up another 50 percent in two years.

It will be possible, using the computer generated tables and computer stored text sections, to develop interim reports shortly after the initial legend is developed. As a result, we can make soil survey information available as the mapping is done.

As another aid in speeding up the publication process, we have been looking at possibilities in the cartographic arena. We've reduced the amount of map finishing work, and hope to eliminate it. Soil maps should be ready for the printer as soon as the field work is done.

This month, funds are expected to be available for awarding a contract for the Advanced Mapping System that I mentioned at your last work conference. This sophisticated system will be used to provide the complex maps for all SCS operations, digitize published soil surveys and prepare interpretative maps from data stored in a computer bank. The system is supposed to be delivered next January and may be fully operational by mid-July of our Centennial Year. The Advanced Mapping

System will further help reduce the finishing needed for all SCS operational maps. The man-years saved there can be used to accelerate the soil survey and other priority programs of the SCS.

With all these aids, I think we are coming much nearer to the goal of completing a published soil survey within one year after the mapping is done. The faster process will help eliminate such troublesome backlogs as the 500 soil surveys that are currently completed but not published. During the past fiscal year, 80 soil surveys were published and distributed. We want to expand this "umber to 150 annually within the next few years. With the aid of bright ideas from many sources, good equipment, and full cooperation among all the agencies concerned, I have no doubt that we can eliminate the backlog. By the end of this decade, soil surveys should be published on a current basis. But to attain this goal, many details of field operations will need close attention and careful scheduling.

We plan to do the soil survey mapping on field sheets of the same size and scale as that of the atlas sheets in the proposed publication. Field sheets will be inked on film transparencies and stick-on symbols will be used. Soil surveys will be progressive, with a completion date of less than 6 years. The first draft of the manuscript for the published survey, including the maps, will be on hand for the final correlation. High-quality maps will be available for interim use almost as soon as field sheets are completed.

"A soil survey of the nation that is complete and current" is a" important goal of the Service's Framework Plan. We've met about 55 percent of the goal so far. To achieve it, we will work to place continuous emphasis on soil survey production. We'll try as much as possible to let district conservationists solve on-site assistance problems of landowners and operators and keep the soil scientists at the business of producing soil surveys.

To achieve our goal, we also will need increased support from other agencies and organizations. We appreciate the greatly accelerated support that has come from Federal, state, and local units of government over the past few years. In fiscal 1974, the estimated contribution of cooperating agencies was about $3.8 million and about 245 man-years of time. Increasingly, personnel ceilings have caused SCS to get others to hire soil scientists. Probably there are more people paid from other sources in the soil survey work than in any other SCS activity.

Much of the increased funding and staffing support has come about because of increased public awareness of the many uses of soil survey information--

--Because people have relied on the soil survey as a vital tool in farm and ranch planning;

--And because People have recognized the need for soil information in making intelligent decisions about land disposal of wastes, water quality, highway planning, recreation planning, and virtually all other aspects of land use planning and control.

Many of you have contributed to that understanding, and I compliment you for the success of your efforts. Where you see cases in which decisions are being made without full consideration of the basic data that are available, I urge you to go all-out in your efforts to assure proper use of the data. There are still many areas where soil survey information is available but not being used, and we cannot relax our efforts in this direction.

There are available published papers and other explanations of many, many kinds of applications of soil surveys. Some of these are really innovative, and you will find them useful in convincing key people of the value of soils information. I would urge you to keep well informed about the availability of such explanations.

SCS has tried several public information efforts to let people know about soil surveys. The latest, which most of you have seen, is a series of 9 leaflets recently published and distributed by SCS that explain the ways in which soil surveys are helpful to different users. These have proven so popular that our first printing of 100,000 copies of each leaflet has been exhausted in just a few months. Reprints have been ordered.

We have also done a multi-media slide presentation, "Underfoot", that you have seen at this meeting, along with press releases, television programs, radio and TV spots, and magazine articles.

The aim of all these efforts is to let people know that help is available in determining kinds of soil and their limitations and potential. I'd like to stress the last item in that list--soil potential. During the past several months there has been increasing encouragement from the Department and others for the SCS and other agencies to assume a strong role in advocating sound land use decisions, in addition to our more traditional role of merely presenting the facts and alternatives. The SCS state conservationists, at their meeting last fall, recommended that such decisions be based on soil potentials developed through an interdisciplinary approach using soil surveys and other natural resource data.

So we have a clear mandate to extend our soil interpretations beyond the identification of the kind and degree of soil limitations. To determine soil potentials, we will need to consider practices that might be used to overcome soil limitations and something of the cost or local feasibility of these practices. Local objectives or policies also will get full consideration.

Soil potentials can contribute to a positive approach to resource planning, whereby we give emphasis to those uses that are well suited rather than those that are not. This effort must involve all our technical disciplines, and we must move ahead with a full definition of the soil potential concept and guidelines for its development and application.

We could use a positive approach to land use and conservation treatment in America. It is time to quit patching and repairing and solving crises after they have already come along. It is time, for example. to identify areas of prime agricultural land that need to be preserved from urban development or from other uses that would end--more or less permanently--the productive capacity of the land. Soil surveys can help pinpoint these areas for local or statewide planning groups.

Soil surveys can help in selecting land for many uses, not just to avoid mistakes, not just to correct pollution problems, but to bring about the kind of communities that Americans want.

As I said at your last meeting, American people--farmers, developers, and land users of all kinds--are not an interference with your work, they are the reason for it. And they need and want your assistance. We want to speed the process of publishing and distributing high-quality soil surveys because communities and individuals are having to make decisions faster...because changes are more rapid and wide-spread in land use, land ownership, and the technology for manipulating land.

The time for the discipline of soil science to aid America in catching up and getting ahead of resource "dilemmas" is now. Your cooperation, your dedication, and your enthusiasm will be vital.

CONFERENCE SUMMARY

William M. Johnson*

Our Conference this year has more international flavor than most of them although our Canadian friends are regular participants, and we have had visitors from abroad at several of the earlier conferences. Delegates from FAO, England, and Mexico along with those from Canada have made this a broader and more useful session. I look forward to welcoming them and others at our 1977 Conference. The reports we received from our colleagues abroad have been particularly valuable. Dr. Dudal's account of current initiatives in FAO gives us a perspective on soil surveys and land resource appraisals throughout the world, particularly in respect to world food production potentials. It presents a challenge to soil scientists everywhere to accelerate the survey and evaluation of soil resources.

Our Canadian associates remind us that soils with permafrost have special production capabilities and must be evaluated along with less exotic kinds of soils. The work of the Canadians on a soil information symposium will be extremely helpful to us as we develop our own system. The International Soil Congress to be held in Edmonton in 1978 demands our cooperation and assistance. We look forward to working with Canada, especially in preparing for tours that include stops in the U.S.A.

The delegation from the Republic of Mexico gave us an insight into the development and progress of the soil survey in that country that we have been lacking. With emphasis on surveys for irrigation development, the Soil Survey Division of the Bureau of Water Resources has made great strides in inventorying and evaluating extensive areas of Mexican soils. The 16mm sound film presented at the Conference was an impressive review of their field and laboratory program.

Mr. Smyth's report on activities of the Land Resources Division of the Ministry of Overseas Development was of singular interest to the Conference, covering as it did the broad geographic scope and widely varying conditions being studied. The logistical problems in some of these surveys sound strange to us, but the basic technology and interpretations are familiar. The examples of the map series from Guadalcanal Island were impressive in their scope and detail.

Reports from cooperating agencies including USGS, ARS, BIA, BLM, USBR, CSRS, FS, and ES described a wide range of activities in soil survey and supporting research and application. Most of the current land resource issues of the United States are getting attention from several federal agencies. Rehabilitation of strip mine lands, soil and water salinity. land resource analysis for land use planning, hydrologic modeling, crop yield models, nonpoint sources of pollution, water use efficiency, remote sensing and computer data handling, environmental quality, and many other issues are being addressed by a considerable group of agencies.

*Deputy Administrator for Soil Survey, Soil Conservation Service. Washington, D. C.

Similarly, our colleagues in land grant universities throughout the country are attacking many of the same problems of soil surveys in relation to resource use and management, including evaluation of soil potentials, soils and socioeconomic criteria for land use planning, improvement of soil descriptions and soil interpretations, encroachment of urban activities on farm lands, and models for rating alternative uses of soils. Many of the land grant universities are actively engaged in initiatives to register professional soil surveyors in the states.

As usual, much of our discussion has related to problems rather than accomplishments, yet our progress has been substantial.

This year's committee reports show a depth and breadth of study and thought that is commendable. We have some of the familiar reports on soil survey publications. water relations, kinds of soil surveys, and organic soils; and we have some new ones on waste disposal, soils and soil materials disturbed by mining, and measuring sources and yields of sediment. Committee chairmen and committee members deserve our thanks for their hard work and accomplishments. Most of these reports are progress reports rather than final ones. We must continue our efforts to improve both the theory and practice of soil survey in all its many facets--soil identification and classification, soil mapping, soil description, and soil interpretation, particularly the evaluation of soil potential for the full spectrum of uses.

Soil surveys have never been more appreciated nor more in demand. There has never been such great opportunity for contributions to this urgent task of surveying and appraising soil resources. Until we meet again two years from now, I urge all of you to give your best efforts to this tremendous task.

TECHNICAL COMMITTEE REPORTS

MODERNIZING SOIL SURVEY PUBLICATIONS

Committee 1

The original charges set out for the committee were:

1. Review procedures for coordinating interim reports with the published soil survey. Prepare guidelines for interim reports--include both text and maps. Assess the value of the various interim and special reports, including maps, and recommend suitable formats.

2. Survey the needs of users for soil information that can be supplied by soil surveys. Test the adequacy of the present form and content of the published soil survey in light of today's users' needs. Recommend action to the conference.

In order to handle these topics, four subcommittees were established with more specific charges. Committee work was done largely by correspondence. Reports were written and circulated to participants before the conference and were discussed at the conference.

A summary of the recommendations resulting from the conference are as follows:

A. Interim and Special Reports.

1. The Committee defined interim reports as those issued during the course of the survey. The accelerated program of publishing soil surveys within 12 months after field work is completed preempts the need for interim reports.

2. Interim reports will include descriptions and interpretations that are consistent with the data that appear in the final publication.

3. States use coordinated soil interpretive data in interim reports.

4. States be encouraged to use the automated computer tables and Linolex processed text for interim reports.

5. States be encouraged to map on the same image and at the same scale as will be published.

B. Form and Content of Published Soil Survey.

1. The states be encouraged to develop with their cooperating agencies models for the soil formation section of published soil surveys by major land resource areas or land resource regions. These models will be used by party chiefs following the techniques for modular writing for preparing sections in the manuscripts.

C. Printing and Binding.

1. Where orthophoto base maps are available and mapping is done at the scale of publication, the state be given the opportunity to publish the text bound in one or two volumes and the large (22" x 27") maps folded and placed loose in a gusset envelope with text.

This procedure also requires the printing of the legend on the borders of each sheet. Unfolded sheets would be available for distribution to various users.

D. Interpretive Maps for Soil Surveys.

1. Participants of the National Cooperative Soil Survey should be encouraged to develop maps with soil interpretations that reflect the interaction between soil properties, land use and other resources rather than single feature maps.

2. States be encouraged to adopt a procedure for digitizing soil surveys that is statistically sound for county, state regional or national inventories. The LIM Division of SCS Soil Survey should provide the leadership for developing such a procedure.

Other Recommendations:

1. That the National Work Planning Committee "Modernizing Soil Survey Publication" be continued and that it deal with models for various sections of the soil survey text manuscript.

2. Regional conferences be encouraged to establish committees to deal with models for soil formation and other sections in published soil surveys during their next work planning conferences.

3. Regional committees should also prepare sections that can serve as guides for the use of the soil potential concept in soil survey publications.

4. The national committee initiate plans for coordinating crop yields by named kinds of soil that are acceptable to all users of soil surveys.

The individual subcommittee reports are attached along with recommendations and a record of the discussion of the recommendations from the entire conference.

Keith K. Young, Chairman

INTERIM AND SPECIAL REPORTS

Subcommittee 1A

Charge 1. Review procedures for coordinating interim reports with published soil surveys. Prepare guidelines for interim reports--include text and maps. Assess the value of the various interim and special reports, including maps, and recommend suitable formats.

A. Past procedures for coordinating interim reports with published soil surveys has been a hit or miss proposition, mainly because of inadequate review procedures. Some soil maps also have not been adequate, and on occasion, just plain bad for one or a combination of reasons.

Text of interim and special reports must be consistent with the published soil survey. This is not to imply the text must be identical, word for word, because interim reports may be written for special interest groups whose only desire is information pertaining solely to engineering, woodland, farming, or wildlife. These reports must be tailored to the needs of the users, whoever they might be.

B. Guidelines for interim or special reports should be in keeping with accelerated soil survey publication procedures (Advisory SOILS-13, June 17, 1974). Text, tables, and maps must be of the same quality and accuracy that is demanded of published soil surveys.

1. Maximize the use and capabilities of mapping unit descriptions stored on cassettes, computer generated tables, and computer generated single purpose display maps.

2. Our present review procedure must be modified to include not only an in-state interdisciplinary review, but TSC multi-disciplinary review prior to publication. The time requirement for this review will be a minimum if modular mapping unit descriptions are extracted from stored cassettes, and tabular data from stored scs-Soils-5 forms.

   Our present review procedures are not working well in some regions but seem to be working well in others. The discussion groups did not want to prescribe a uniform review procedure. A TSC multiple disciplinary review prior to publication might work well in the West but would not be possible in the Northeast because of the large number of township interim reports.

   The responsibility for the quality is the state conservationists. However, the TSC's should offer help and guidance to those who need it.

3. All soil maps be constructed in a same manner as those to be published in a published soil survey to insure high quality standards. Encouraged states to map on the same scale as will be published.

C. The value of various interim and special reports has been definitely established. Unfortunately in some past instances it has been a more useful document than the published soil survey because of the time lag between survey completion and publication.

With the implementation of the new accelerated soil survey publication procedures, interim reports take a new meaning. When soil surveys are published within a year after completion, the need for interim reports is considerably diminished. However, reports made during the course of the survey may be needed, especially for cooperators who are sharing the cost of the survey.

Interim reports may contain a limited amount of information or a lot depending on the local needs. Minimum requirements for interim reports are now being circulated for comments to SCS state offices and cooperators in the National Cooperative Soil Survey.

Charge 2. Survey the needs of users for soil information that can be supplied by soil surveys. Test the adequacy of the present form and content of the published soil survey in light of today's users' needs. Recommend action to the conference.

A. Most needs of users of soils information are being supplied by soil survey with few exceptions; e.g., landslide potential, unsurfaced motorized trails, soil limitations for fencing, soil limitations for range seeding, etc. There is also the age-old question of "So these soils have severe limitations--what do I do about it?" that keeps cropping up.

1. Criteria should be established for each new interpretation as it arises. The criteria in turn should be reviewed by Washington, Technical Service Centers, and applicable states. These interpretations, when used by any state, would be based on the established criteria.

B. Many of our users of "published soil surveys" find the document exceedingly cumbersome to wade through. This is also a valid criticism of some of our interim and special reports. There are Just too many cross-references that must be made for our users to obtain the full picture. This is also of major concern to reviewers of the manuscripts. In some instances interim and special reports have been written without regard to the need of the intended user. These documents have been as complete as a published manuscript with descriptions of capability units and range sites. This material, though of general interest, only clutters the reports when the intended user is interested in town and county planning.

We believe the new format for published soil surveys will alleviate the problems of cross-referencing on the part of our users. Full utilization of the Linolex word. processing equipment will afford us a capability of description storage, editing, and rapid reproduction we have "ever had. Also full utilization of computer generated interpretations tables will afford us a relatively low cost, rapid reproduction of coordinated interpretive data.

1. Interim and special report outlines should be specific to the needs of the user. The outline should be mutually agreed to by all parties concerned.

2. A concerted effort should be made to convert soil handbook mapping unit descriptions into the new format--each to stand on its own as soon as possible. These, in turn, should be stored on cassettes.

3. SCS-Soils-5 forms be completed for all soil series, reviewed, and stored in the computer file as soon as possible.

4. All interim and special reports be based almost entirely upon computer and Linolex generated data.

5. Soil survey areas nearing completion be established as trails in the various regions to assess its usefulness and acceptance by users of soil survey information. A" interim report of the trial areas be published setting forth the weighting criteria used to determine soil potentials in addition to materials recommended in Charge 1 B2 above.

   There have been continued demands by some users for us to present soil interpretations on the basis of soil potentials rather than soil limitation. This approach is good and possibly more meaningful to many of our users. It will also serve to weight down purely economic criteria that now exists in our urban interpretations (e.g., stoniness). The weighting criteria to be used in any given survey area must, of necessity, be arrived at by a panel of our users, not soil scientists. This will not only remove bias on our part but allow our users to become a party to establishing the potential of the soils of a" area.

Recommendation

After consideration of the subcommittee report, the discussion groups of the conference made the following recommendations:

1. That interim reports be defined as those used during the course of the survey. The accelerated program of publishing soil surveys within 12 months after field work is completed preempts the need for interim reports.

2. That interim reports will include descriptions and interpretations that are consistent with those that appear in the final soil survey publication.

3. That states use coordinated soil interpretation data in interim reports.

4. That states be encouraged to use the automated computer tables and Linolex processed text for interim reports.

5. That states be encouraged to map on the same image and at the same scale as will be published.

Discussion.

J. Rourke -- Can states use tables based on interpretations but expressed as potential.

K. Young -- Yes, if potentials have been worked out locally.

L. Bartelli -- The final product must be consistent with the coordinated interpretations. No conflict with policy to carry the interpretations to its final use.

L. Langan, Chairman
R. W. Johnson
R. C. Huff
F. W. Cleveland
R. F. Farmer
E. P. Whiteside

FORM AND CONTENT OF PUBLISHED SOIL SURVEYS

Subcommittee 1B

Charge 1. Review the table of contents of our present soil surveys and make recommendations in light of today's users needs.

A proposed table of contents is attached. We received the following comments about the proposed table of contents:

1. Three members of the subcommittee thought the general nature of the county section belonged near the beginning of the report.

2. One member proposed that the descriptions of soils and use and management section should be one section using the established series descriptions, mapping unit details, and SCS-Soils-5 forms for the series in this section.

3. Most responded to the question of "alphabetical order" or "order of importance" of the use and management section that they prefer to have this section by "order of importance". They thought this section should be quite flexible.

4. One member proposed that the general soil map discussion be placed just before the map itself in the report.

5. An interesting set of suggestions came from research conducted by Mr. Roger Springman, a graduate student in Resource Develop ment at Michigan State. A summary of some of his major points are as follows:

   a. Divide the soil survey into two documents-maps and text.

   b. A better format is needed to present septic tank information, e.g., map showing location of problem areas.

   c. Interpretation tables for general soil maps.

   d. Tables by subject matter (user group orientation).

Charge 2. Explore the possibility of writing modules for the Factors of Soil Formation section by Land Resource Regions.

Examples for the "Factors of Soil Formation" section were submitted by the committee. These examples came from different sections of the country and differ greatly. The paragraphs on parentmaterial in the best sections are specifically written for a county. It would be difficult to write a module for parent material for an area larger than a county. Perhaps the best we can do is to give good examples to the author. Other factors of soil formation are more easily ddapted to modular writing at least on a major land resource area, if not a land resource region.

P. R. Johnson
J. C. Powell
E. P. Whiteside
R. L. Cunningham
F. M. Scilley

The discussion groups compared the outline attached to the Committee 1B report to the one now being developed by the committee appointed to implement the task force recommendations on accelerating soil survey publication procedures. The two are in close harmony. The task force recommendations are shown in longhand on the attached outline.

Recommendations.

1. That the states be encouraged to develop with their cooperating agencies models for soil formation sections of published soil surveys by major land resource areas or land resource regions.

Discussion.

R. B. Grossman -- This is the part we should not modular write.

W. M. Johnson -- 1 agree in principal, but this is a very difficult chapter for many soil scientists to write.

R. B. Grossman -- At the December meeting of the Principal Soil Correlators, I thought we agreed to omit those formation sections if they are not adequate.

K.K. Young -- Yes, the chapter is optional, however, there is a need to educate users on how soils are formed. Many states will continue to have this section.

R. Daniels -- Many states have phyaiographic regions that lend themselves well to modular writing. One well written formation section could apply to many other counties.

W. M. Johnson -- We have to tailor parts of this section to the survey area.

R. Daniels -- Maybe about 50 percent could be canned.

K. K. Young -- The committee felt that parent material does not lend itself well to modular writing but other factors of soil formation and soil forming process are more easily adapted to modular writing.

Attachment
P.R. Johnson
8/14/74

CONTENTS .

(Corrected according to task force recommendations)

PRINTING AND BINDING

Subcommittee 1C

The present format for publishing soil surveys was initiated in 1957 with the Pasquotsnk County, North Carolina, soil survey. Although this format has served us well over the years, there may be better ways to print and bind the survey. Subcommittee C has investigated several alternative ways of printing and binding soil surveys.

In order to get some comparison of the costs of printing and binding surveys in the several formats, we asked GPO to give us the cost of the newly printed soil survey of Cowlitz Area, Washington, and to estimate the cost of printing it in the additional formats. We hope that the cost of printing and binding surveys will not become an overriding consideration in evaluating these alternatives, but it does happen to be about the only criteria that we can quantify easily.

We discuss the formats by giving a description, the advantages, the disadvantages, and for some formats, a fuller discussion.

Format 1, the Standard Format.

In the standard format the text and maps are bound together in one volume. The maps, normally 11 x 17 Inches, are folded by machine, hand collated, and stitched with the text. For surveys containing a large number of maps, such as in the soil survey of the Island of Hawaii, "brick guards" are needed to build up the spine,

The maps are normally printed in two colors. The photomosaic is green, the line work and cultural features are black. The cost of printing Cowlitz Area, Washington, in the standard format is $7.13 per copy (2,500 copies cost $17,802).

Advantages: (1) The format is familiar to users; (2) text and maps are bound together in one document; and (3) the single volume stacks well on a bookshelf.

Disadvantages: The disadvantages are (1) the costly method of printing and binding, mainly because of the extra handwork, and (2) unfolding the maps is inconvenient for users.

Format 2

Text bound in one volume, the maps (11 x 17") folded and bound in another, and both volumes placed in a gusset envelope. Cost is $9.03 per copy. No examples.

Advantages: (1) Maps bound together, so can't get out of order or lost; (2) could hand out text separately if user was only interested in text; and (3) could publish update text only.

Disadvantages: (1) Unhandy to use because in envelope. (2) most costly method of printing and binding; and (3) unfolding maps inconvenient for users.

Format .

Text bound in one or two volumes, large (22 x 27") maps folded and placed loose in gusset envelope with text. Examples are San Diego Area, California, (text in two volumes); King County Area, Washington; and Tahoe Basin Area, California-Nevada. The costs were not estimated for Cowlitz Area because of the difference in map size.

Cost comparisons can be made in a rough way between this format and the standard format by comparing San Diego, California, and the Island of Hawaii:

	San Diego, California (Format 3)	Island of Hawaii (Standard Format)
Size of area	2,205,000 Ac.	2,579,000 Ac.
Scale	1:24,000	1:24,000
Number of map sheets	76	195
Number of text pages	222 (2 volumes)	115
Year issued	Dec. 1973	Dec. 1973
Number copies printed	4,400	2,000
Cost per copy	$ 12.95	$ 19.78

Advantages: (1) Lower binding costs, especially for large survey areas; (2) fewer maps of larger size; (3) easier to use on large parcels of land; (4) slimmer text for those who are mainly interested in interpretation; and (5) ease of updating interpretation.

Disadvantages: (1) Loose maps soon get out of order and are difficult to find; (2) maps have to be unfolded to use; (3) maps tend to tear with heavy use; and (4) maps can get lost and text can be separated from maps.

Discussion: Perhaps even more savings could be attained in Format 3 with some of the new mechanical stuffing techniques developed by the Japanese. Also, this alternative could be made even more attractive by printing the gusset envelope so that the name of the survey appears on the "spine." An example of such a printing is the Block Statistics, Washington, D.C., Md., Va. Urbanized Areas, U.S. Census of Housing 1970.

An advantage related to this format, but not restricted to it, is the scale of mapping. The scale of the San Diego and Hawaii surveys is 1:24,000, the same scale used by USGS on their 7-1/2 minute quad sheets. It is also the scale used on aeronautical charts and many maps commonly used by planners. It seems a distinct advantage to print the soil maps on the large (22 x 27") maps to correspond exactly with the area covered on the USGS maps.

Format 4.

Change trim size of text and map to 17 x 11", bind together, and soft fold. Text is printed in four columns per page. Cover printed with photograph on right half of cover and spine title on fold line. No exact examples printed. The interim report of Texarkana is similar. The cost if $6.03 per copy.

Advantages: (1) Fewer pages needed for text; (2) lowest cost of any alternative because less press time, easier to bind; (3) maps flat, do not need to be unfolded.

Disadvantages: (1) Large document when open; (2) soft fold is bulkier on book shelf.

Format 5

Reduce maps to page size, bind with text. No examples published, but similar to the interim report of Rend Lake Area, Illinois. The cost is $6.51 per copy.

Advantages: (1) An economical method of binding because no hand labor required; (2) the survey is all together and easy to use, particularly on small parcels of land.

Disadvantages: (1) Twice the number of maps because half the size; (2) more costly map preparation because of increased number of match lines (extra map cost not shown in printing cost above); (3) more difficult to use the small maps on large parcels of land.

Discussion: Under new procedures, the mapping would be done on the publication base. This means that mapping would have to be done on about twice the number of maps as normal. The amount of joining would increase, causing increased review time and greater possibility of errors, a serieous disadvantage when the total cost of the survey is considered.

Format 6.

Increase the size of the map to 22 x 17 inches, and bind with text. The upper half of the 22-inch side is bound, the lower half is cut so map can be folded into the document. Cost is uncertain. Fewer maps are cheaper, but Upping, folding, and binding maps with brick guards is expensive.

Advantages: (1) Single volume stacks well on shelf; (2) fewer maps of larger size; (3) easier to use on large parcels of land.

Disadvantages: (1) The maps have to be unfolded to use, and (2) maps tend to tear with heavy use.

Additional alternative procedures can be used to reduce somewhat the high cost of printing and binding or to imporve the readability or usability of the survey.

1. Print maps in black only with a single pass through the press. One contract printer expects a 17 percent reduction in bid price over the two-color method. This could be done in two ways:

   a. Line work could be done directly on the photobase and shot as a half-tone. Example: "Texarkana Metropolitan Area" special soil report.

   b. Line work done on an overlay, make one line negative and one half-tone negative and composite them for printing. Quality is a little better with this method than "a".

   In either case, care must be used in negative making to extract the utmost detail and tonal qualities. Care must also be exercised on the press to print the full tonal range of the negative.

2. Eliminate different colors of stock for covers. This is not necessarily a cost savings, but is a great convenience and time

3. Eliminate the running heads from the top pages in the published survey. The running heads are used by GPO to keep the printed signatures inside the right cover. When we furnish GPO with mag tape, this should be an unnecessary precaution.

4. For surveys that are placed in gusset envelopes, print the envelopes in such a way so that the title of the survey is printed on the spine, so the title shows when standing on a shelf. Example: "Block Statistics", U.S. Department of Commerce, Bureau of Census, 1970.

K. K. Young, Chairman
G. H. Simonson
Carter A. Steers
W. A. Hamilton
Harold I. Owens
Warren Bell

The four discussion groups evaluated each of the formats. All groups like format 1, the standard format, and 3, large map folded and placed loose in gusset envelope with text. One group thought format 4, soft fold, had merit.

Recommendation.

1. Where orthophoto base maps are available and mapping is done at the scale of publication, the state be given the opportunity to publish the text bound in one or two volumes and the large (22 x 27") maps folded and placed loose in a gusset envelope with the text (format 3 of the committee report).

   This procedure also requires the printing of the legend on the borders of each sheet. Unfolded sheets would be available for distribution to various users.

Discussion

W. M. Johnson - clarify the map scale - is this the 7-1/2 minute quad at 1:24,000?

K. K. Young - Yes.

W. M. Johnson - This system won't work at 1:1584.

K. K. Young - Probably not but we might want to consider 1:20,000 as an option.

R. D. Heil - One disadvantage is that boundaries of the map are not related to sections so would have a problem of putting parcels of land together.

K. K. Young - Right, but this may not be a serious disadvantage. Some planners like quad size maps. Soil maps would fit the same scale.

J. A. Gockowski - If we go to 7-1/2 minute quads we give up sections but we are giving them up now when we use orthophoto quads. we cut one quad sheet into three pieces.

W. M. Johnson - Do we show section lines or corners?

J. A. Gockowski - We show section corners and numbers.

J. D. Rourke - Would the legend be on each sheet or could we use one legend sheet.

K. K. Young - Many feel it is best to repeat the full legend on the right hand margin of each sheet. This is most efficient.

J. A. Gockowski - Legend on side may make the map too large for the standard presses. Need to check on this.

W. M. Johnson - Some surveys would have too many mapping units to put on margin of each map.

J. A. Gockowski - We could print the legend on the back.

W. M. Johnson - No, that is most difficult to use.

W. Wertz - Many maps are constructed in this way.

G. J. Post - Is this recommendation only for the 1:24,000 scale?

K. K. Young - Yes. That is the only scale the committee evaluated.

G. J. Post - Could we take the current high flights and put them together into this format?

W. M. Johnson - Probably best to use the quads. Not much advantage for others.

K. K. Young - Right now the recommendation is limited to 1:24,000. The format may not be as applicable to 1:20,000

INTERPRETIVE MAPS FOR SOIL SURVEYS

Subcommittee 1D

Charge 1. Review the options available for making interpretive maps. Outline the procedures, costs, processing time, and applicability of each.

Because of the wide variety of possible interpretations and the cost of map production, we have for the most part avoided making interpretive map*. New techniques now available permit us to generate interpretive maps in a short period of time at reasonable costs. Most of the new options available for providing interpretive maps are with the computer. Several states are producing interpretive maps with the Map Information and Display System (MIADS). Other computer methods are available, such as Spatial Proportions and Interpretive Tables (SPIT), and Advanced Mapping System (AMS) when operational.

Originally the AMS was intended to do the map compilation and finishing for the published soil survey. Last year a task force determined that states could do the compilation andfinishing of soil maps so the AMS was re-designated to produce base maps, topographic maps, and interpretive maps from detailed soil maps.

When we analyze the procedures for placing soil data into a data base we find that there are at least three different ways of presenting the data to the computer. Soils can be presented by cell, polygon, or line segment. The cell programs are in widest use at this time as it requires less effort for manual coding and programming cell type programs. Some of the disadvantages are: (a) the amount of time required for manual coding, (b) the user is able to make a more detailed map than originally coded, (c) artificial and inaccurate boundaries, (d) limited scale changes, and (e) an expert must be involved to determine the type of soil to be coded in each cell.

Digitizing polygons requires a manual or automatic line follower. The soil lines are recorded in the same location as on the soil map when using a digitizer. One of the disadvantages is that all lines must be digitized twice. This requires twice as much computer storage for recording and processing. Also, if you are using a manual digitizer, it is impossible to follow the line exactly the same each time, therefore, there are two sets of coordinates for the same line. When this is plotted it does not look very professional.

The AMS will use line segments. By digitizing line segments it will require that all lines be digitized only once. Each line will have a header indicating the soil symbol on each side of the line. To produce an interpretive map a conversion legend will indicate which lines are to be deleted and which lines will outline the different interpretations. An interpretive map prepared by the AMS will look like a map prepared by a draftsman and can be reproduced at any scale. Another advantage of digitizing line segments is that with some additional computer processing this information can be formatted for polygon and cell programs.

The AMS will not be operational until 1976. Meanwhile the MIADS program is beingused for making interpretive map displays.

Oklahoma has placed into computer storage 60 counties or 78 percent of the state. The soil survey was generalized into 40-acre cells by a soil scientist or someone trained by a soil scientist. This basic information was first stored in the computer which later produced an average of 10 interpretive maps per county in black and white. In Oklahoma County 11 interpretive maps were produced in color.

The average time and cost of producing interpretive maps in Oklahoma has been:

1. Generalizing detail map and coding	10 days	400.00
2. ADP Processing for 10 different interpretations	2 months	150.00
3. Cartographic processing of 15 to 20 black and white copies of 10 different interpretations	3.5 months	300.00
4. Cartographic processing of 100 color copies of 10 interpretations	7 months	750.00

In Howard County, Maryland they are trying to make it easier to code the soil symbols by using the digitizer to record soil data on magnetic tape directly without punching computer cards. They are using the digitizer to record X and Y coordinates and the soil symbol on magnetic tape and then going through a computer program to convert to cells. The two-character cell size for the MIADS program is 3.06 acres. The interpretive maps produced by this program will be printed on a line printer.

The digitizing process has been structured so that data can be entered into either the MIADS or SPIT program. The SPIT program is now being modified to run on the IMB 360/370 computer.

Digitizing of one watershed in Maryland has been completed, with a total area of 18,516 acres. Costs are going to vary greatly since they had a GS-7 doing the digitizing on the watershed and now are using $2.00 per hour summer employee to digitize Howard County, Maryland.

Following are some of the costs that were encountered on the soil map of the watershed:

	Time	cost
1. Digitize 17,468 cells	50 hours	$500.00 (OS-7 with overhead)
2. Computer processing Convert digitizer format to cells and print soil map	13 seconds	20.00
3. Computer processing Print MIADS interpretive map	3 seconds	4.50

MIADS interpretive maps have been used primarily to guide broad-based community planning. The field people feel colored maps are well worth the extra cost but are disappointed with the increased time lag to get them. Most feel the black and white maps can be used effectively, especially with a few select color maps to attract attention. The limitation ratings for each interpretation of the basic soil map has been worked out for each individual county. This has taken up to two days per conty. Once the National Data Bank at Ames, Iowa is operational, this could be programmed to save most of this time.

Charge 2. Assess the need of users for interpretive maps and recommend kinds of maps to include in published soil surveys, special, and other reports. Prepare guidelines for making interpretive maps.

Many users of soil surveys are concerned with only a few select interpretations. Many also prefer interpretive maps over the use of interpretive tables with the regular soil survey. Soil survey maps are used at both the general and detailed level.

Our problems in making generalized interpretive soil maps from existing detailed soil maps are related to the utility of the produced map, the cost, and the' time involved.

The utility is related to accuracy or maximum agreement with the detailed map andthe degree of detail needed by the user. We need more study on minimum cell size matching the decision making unit of the user.

The cost is related to the utility. The NARIS program under development in Illinois is a comprehensive program but would cost 5.5 million to implement and 1.5 million annually to operate. How much utility can we afford? We need guidelines from planners on how much detail is needed and how much they are willing to pay for needed information.

The time factor is extremely important. We need to get information to the planners quickly before they move to another area or the plan must go to press. Far-reaching, expensive land use decisions are made each week, with or without adequate data.

Communications with the regional and community planners indicate they use soil surveys at both the general and detailed level. Soil survey information and interpretive maps form a basis for resource analysis which is necessary before plans are completed and before land acquisitions and the steps that follow can take place. Generalization at a county, regional or state level of soil survey information is necessary and will and should serve as one of the basic criteria for land use plans at these same levels of government. Present interpretive procedures and computer printouts for various uses go a long way towards presenting the overall picture. With continued refinement and education these maps will continue to serve as important tools.

There needs to be some attention given to the graphics relative to interpretive maps in order that they are interesting and meaningful to those who are most interested in reaching people who make land use decisions. OUr real goal is to communicate soils information to the planner and decision maker.

Many in the interpretation field see the need of retaining or expanding the amount of detail rather than generalization. With the computer and other printout refinements a methodology needs to be developed that can read section by section, directly or indirectly, from the soil survey information that is recorded. Attention should be givne to the delineation line in order to phase from one soilcondition to another. The AMS system under development we feel will meet these needs. In the use of present soil survey information we are careful to stipulate that this information is to be utilized for planning and design purposes when actually in most cases the infomration is much more valid. For example, interpretive maps for well drained soil conditions in broad delineations with few inclusions presently must be treated in the same manner as variable drainage conditions, complex topography and small delineations.

Printout materials should be available on a section basis containing all the information in the published soil survey plus an interpretation of the realiability and variables of the delineated areas. We need to know the accuracy of prediction of areas enclosed with lines at different scales, and to inform the user the reliability will be low for certain kinds of interpretations at small scales. We have two alternatives -- (a) Make maps that offer a certain degree of reliability of predictions such as 50, 60, or 70 percent. The legend or kinds of units, map scale, kinds of generalization, and the kind of interpretation could be adjusted to reach this goal. (b) Furnish andy kind of map available which user wants but put a reliability range on the map. Some maps may be at a low degree of reliability, especially in highly generalized areas of contrasting soils.

Graphic presentation of interpretive maps should be improved to be more meaningful. In assessing our need for interpretive maps we should also consider the television screen type of equipment (CRT) with soil interpretations on tapes which will allow quick display of information for planners. The purpose for interpretive maps is to furnish a working tool to a specific group of people for decision making. Computers can provide maps fast, especially in limited quantities. Many interpretive maps need not be included in the publication program.

Interpretive maps of soil survey become a part of a greater system in planning. Resource planning at the broad level is now being done by computers with soils, geology, tax value, water, population, etc. This information comes from several sources and the reliability differs. To assure the best and correct use of soil survey information we need to work closely during the coordination of data effort. The interaction of maps from different scales could give misleading resluts. We want to assist so that our information is used to maximum advantage and yet not misused.

Finally, we need to consider areas that do not have soil surveys. We need to look for methods to get information quickly for broad-based planning. We can and should provide some soils data long before we have a published, detailed soil survey.

Westal W. Fuchs, Chairman
R. L. Bryan
J. D. Nichols
C. G. Johnson
M. E. Springer
R. L. Googins

Recommendation

1. Participants of the National Cooperative Soil Survey should be encouraged to develop maps with soil interpretations that reflect the interaction between soil properties, land use, and other resources, rather than single feature maps.

2. States be encouraged to adopt a procedure for coding soil surveys that is statistically sound for county, state, regional or national inventories. The LIM Division of SCS soil survey should provide the leadership for developing such a procedure.

Discussion.

J.R.Coover - The recommendation sounds like planning. We have a tendency to be planners. We should predict interaction but we don't do planning.

K. K. Young - That's right. although the prime farmland map that Oklahoma developed goes a step farther than predicting interaction -- it is a kind of planning map.

R. I. Dideriksen - We get the relationships of soil properties to other resource data needed forplanning. We must look at soils and land use on these soils - where the people are. Those relationships define what is needed for planning.

W. B. Peters - I didn't hear potential -- I heard interaction.

K. K. Young - It could be potential or existing conditions. For example, the prime farmland in the Oklahoma county was actual, that is prime farmland now cropped. Another map shows prime farmland in pasture and forest. This map shows the potential prims farmland.

J. A. Rourke - On the basic map, we put down the soil limitations, then we consider what limitations we have to overcome. This goes to potential.

W. M. Johnson - Cower raised a good point, we have no business planning land use. This is for decision-makers or regulators, however, to make an objective definition of prime farmalnd in terms of soil characteristics and other uses is a form of soil interpretations. In the final analysis, what a state does is up to them. This is a politcal decision. If we make maps that show prime farmland, prime forestland, prime grazing land, etc., we are furnishing soil interpretations that will help others make land use decisions.

J. R. Coover - Should these be part of a published soil survey?

W. M. Johnson -Not necessarily.

R. D. Heil - I'm not Sure we have established what prime agricultural land is. The San Louis Valley, Colorado is rocky but a very important potatoe seed producing area, mainly because of the climate. I would use climate for prime farmland criteria rather than soil. Also, access or nearness to markets is more important than soils.

R. I. Dideriksen - This land fits the concept of unique farmland. We have no intent to show what lands should be set aside but we do define and locate the best farmlands -- those that will produce good returns safely with minimum input. We will continue to make interpretations of land suitable for cropland. If the state doesn't have any prime farmland they may still want to set it aside for farm use only.

W. M. Johnson - We want to identify the best lands for crops, some may not be prime but are highly prized because of other factors than soil. We have spoken of these as unique. These are a separate problem.

R. I.Dideriksen - All this recommendation is saying is that if someone identifies a floodplain, a coal strata, etc., that we get statistically sound data so that we can integrate soil data, land use data and other resources data.

T. E. Fenton - You said that only one display system available?

K. K. Young - I should have said only one system (MIADS) is now operational in SCS.

T. E. Fenton - Others are using a different approach...

L. J. Bartelli - But using cell. I suggest we drop the word MIADS.

R. I. Dideriksen - Change to cellular approach

W. Wertz - Are the interpretive maps in soil Survey reports or elsewhere?

K. K. Young - The committee was not specific as to whether these interpretive maps would te placed in a published soil survey.

W. M. Johnson - For pragmatic reasons (cost size, kind of maps to publish) at the moment and for the forseeable future (2 years) there is no prospect to publish in soil surveys any significant quantity of interpretive maps. We won't have the capability to crank out on order for those users who need the information for decision making. We may have to charge for this service with AMS. We will then have the means to publish at the scale of the published map or other scales. We won't have AMS for 2 years.

K. K. Young - On behalf of Committee 1, I move the report he accepted.

Seconded

Motion carried

K. K. Young - Committee 1 moves that the committee, Modernizing Soil Survey Publications, be continued and deal with soil potential and models for soil survey publications. We would urge the regional conferences to establish a committee to deal with soil potentials and models for soil formation chapters in published soil surveys.

Seconded

Motion carried

Recorder: Wes Fuchs

NATIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

January 26-31, 1975
Orlando, Florida

Committee #2 - Improving Soil Survey Techniques

CHARGES

A. Assess the various techniques for using automatic data processing in soil survey reports.

B. Evaluate application of remote sensing techniques for speeding up soil surveys in areas of log-intensity use.

C. Explore ways of improving field mapping operations to increase efficiency and accuracy.

Introduction

A preliminary report was prepared by the chairman from material submitted by members of the committee for Improving Soil Survey Techniques. This preliminary report was presented to the participants at the National Technical Work-Planning Conference. The recommendations that follow resulted from discussions, suggestions, and agreements reached by the four discussion groups and the conference as a whole after considering the committee's report. The preliminary report is included here as part of the overall committee report to the conference.

Recommendations

A. Uses of Automatic Data Processing in Soil Surveys.

1. The Soil Conservation Service should obtain an optical reader and test and evaluate a program to collect and process pedon description data using mark-sense forms. Field testing should include work in at least one state from each area serviced by a technical service center. Other agencies should also be given the opportunity to test the program.

2. The Soil Survey Operations Division should convert the soil series use file now on cards to automatic data processing and work with principal soil correlators, state soil scientists, and others to determine additional needs and uses for data related to soil series use.

3. The Soil Survey Interpretations Division should continue to evaluate the need and feasibility of single-sheet soil interpretations for phases of soil series.

B. Application of Remote Sensing Techniques in Improving and Accelerating Soil Surveys.

1. The Deputy Administrator for Soil Survey, SCS, should establish a team in the SCS to develop guidelines for the application of

new remote sensing techniques that have the potential for improving and accelerating soil surveys especially in critical areas such as the coal fields and oil shale lands of the western states.

2. The SCS team should work with regional technical work-planning conference committees, other federal agencies, and state agricultural experiment stations in a coordinated effort to identify those phases of remote sensing techniques that have potential for application in soil surveys and recommend areas for testing. Close coordination should be maintained with the Cooperative State Research Service in identifying research needs. The Bureau of Land Management and the Bureau of Reclamation, in addition to the Soil Conservation Service, have indicated definite needs for evaluating applications of remote sensing techniques to soil surveys.

3. The Deputy Administrator for Soil Survey, SCS, is encouraged to help obtain reclassification of imagery now unavailable but which has high potential for improving and accelerating many soil surveys. Although full declassification is probnbly not possible, partial availability to improve interpretations appears practical and very worthwhile.

C. Improving Field Mapping Operations.

1. Information on less commonly used and new equipment or techniques having application in soil survey activities should be collected, summarized and included in the National Soils Handbook. This information would include a description of the equipment or technique, its uses, advantages and disadvantages, approximate cost and benefits, and if commercially available, its source.

2. This comnittee, working with committees of regional technical work-planning conferences, should identify, compile, and publicize problems related to soil survey techniques. These problems will be brought to the attention of the Director, Soil Survey Operations, research committees, and others who may be of assistance. Status and progress reports will be made as needed.

3. This committee should be continued as a standing comnittee to carry outthe previous two recomnendations and other charges the conference may assign related to improving soil survey techniques.

In addition to the specific recommendations, a few other noteworthy comments resulted from committee work and conference discussions.

1. The International Society of Soil Science has working groups on soil information systems and applications of remote sensing. Establishing communication with these working groups is encouraged.

a. Working group on soil information systems is under the leadership of Dr. J. Schelling, Soil Survey Institute, Starenggebouev, Prinscs Marijkeweg 11, Wageningen, The Netherlands.

b. Work group for applications of remote sensing is under the leadership of Dr. I. Tolchelnikov, Laboratory for Aerophotomethods, Leningrad B-164, Birzevoi proezd, 6 U.S.S.R.

2. The Soil Conservation Service is compiling a computerized index of soil pedon data. Other agencies with soil pedon data are encouraged to add information about their pedon data to the index. Information about procedures can be obtained from Dr. Klaus W. Flach, Director, Soil Survey Investigations Division, SCS.

3. Assess feasibility of "sing different bases for field mapping and publication to obtain maximum return from each. Some imagery has high potential for improving and accelerating field mapping but not well suited for publishing.

4. An active and well-designed training program is essential to the soil survey. New soil scientists should receive comprehensive training in all basic soil survey techniques. All soil scientists should utilize all the resources and tools available to produce the best possible soil survey.

5. It has been proposed that criteria be inputed into a computer and allowing the computer to develop soil potentials. The feasibility of this program seems reasonable, however, it must be emphasized that the computer output is only a starting guideline and additional judgment must be used prior to application of the rating. Soil Survey Interpretations Division is working on the development of the criteria.

Preliminary Report
September 1974

Committee #2 - Improving Soil Survey Techniques

CHARGES

A. Assess the various techniques for using automatic data processing in soil survey reports.

B. Evaluate application of remote sensing techniques for speeding up soil surveys in areas of low-intensity use.

C. Explore ways of improving field mapping operations to increase efficiency and accuracy.

A. Automatic Data Processing

For quite some time, means have been sought to decrease the interval between completion of soil mapping and the availability of the published soil survey. Various procedures have been proposed. Some have been tried, others only discussed. Early in 1974 a task force under the leadership of William L. Vaught, Director, TSC, submitted a report to Kenneth E. Grant, Administrator, SCS, outlining procedures to reduce publication lag time to less than 12 months. Manuscript preparation, text review, editing, and revision depend to a large extent on ADP techniques. A summary of the implementation procedures for accelerating soil survey publications is presented in SCS Advisory SOILS-13 (6-17-74). Although complete testing of all the involved ADP techniques has not been done, all are considered sufficiently feasible to start implementation.

In addition to the essential procedures needed to achieve the objective of publication within 12 months of completing soil mapping, there are some related ADP procedures that have potential value in the overall soil survey program. Suggested procedures that appear to have potential value are:

1. The use of mark coding forms for inputing soil descriptions into computer storage seams feasible. Montana State University has developed a set of forms that are being evaluated. John Thompson of the Soil Data Storage and Retrieval Unit, Hyattsville, has also developed a trial set that is ready for reproduction and testing. Suggested benefits include:

   a. Facilitating the Input of all soil descriptions into computer storage for subsequent retrieval. Important uses include development and revision of descriptive legends, soil series descriptions, and descriptions of sites sampled for soil characterization and engineering test data.

   b. Facilitating preparation of descriptive legends and soil survey manuscripts.

   c. Obtaining more complete descriptions with more uniform formats.

2. A soil series use file or a mapping unit record file has been proposed. Information contained on the SCS form SOILS-6 is used to recall legend material and develop soil interpretation tables for individual soil survey areas. Data on the form could also be used to file information about soil series and mapping unit "se, acreage, major land resource area, and other related data for future sorting and use. This could be done hy selected soil survey areas, parts of states and eventually entire states and nationally.

3. Some uses for single-sheet soil interpretations for phases of soil series have been proposed. The information could be sorted from SCS form SOILS-5 by using data from SCS form SOILS-6. Information by phases of soil series could be obtained for identifying soils with the same or similar "se limitations or potentials. If the single-sheet interpretation format could be tied to a soil mapping unit record, then possibly, location of soils with similar interpretations could also be obtained.

4. It is proposed to establish a National Soil Survey Investigations Index of soils for which laboratory characterization data are available. Uses for the Index and procedures for assembling the material are given in SCS Advisory SOILS-16 and attachment (7-24-74). The committee supports implementation of this Index and encourages

states to update classification of older data, data that originated in state laboratories, and complete input forms so that this data can be included in the Index.

The committee recognizes that there are many more potential applications of ADP techniques in addition to those summarized in this report. It is also recognized that relating soil survey data to other resource data is also desirable to obtain optimum use of soil maps in various land use planning programs. An orderly evaluation of the many possibilities is essential for setting priorities for application. Recognizing this need, the Deputy Administrator for Soil Survey, SCS, recently established a committee composed of division directors and charged them with the overall responsibility to coordinate ADP applications in all phases of the soil survey program This NCSS technical committee for "Improving Soil Survey Techniques" will cooperate with them to the maximum extent possible.

B. Remote Sensing Techniques

Although the term "remote sensing techniques" is extremely broad, the committee activities centered around the use of various kinds of imagery for soil mapping and related landscape evaluations. Many kinds of imagery are possible and available for application to soil surveys. Generally, these can be separated as photographic and non-photographic. Photographic imagery includes panchromatic, infrared, color infrared, and various color negatives and positive films. Non-photographic imagery is compiled from data throughout the electromagnetic spectrum by various methods. The later systems are more complex than can be briefly described here. The ERTS satellite imagery is an example of non-photographic imagery. Photographic and non-photographic imagery may be multispectral and interpretive value may be increased through the use of various optical and mechanical devices.

Considerable investigations and evaluations have been done in the general field of soil science using imagery obtained by remote sensing techniques. Only a very small portion has been directed toward soil mapping and probably a much smaller part actually has been done using operational soil mapping procedures. As a result, good evaluations applicable to the soil surveys now being done in the National Cooperative Soil Survey program are not plentiful. Many of the evaluations do not include good cost-benefit comparisons between various techniques.

Two excellent summary reviews and comparisons of techniques were published in SOILS & FERTILIZERS, Vol. 36, No. 7, July 1973 and No. 8, August 1973 by D. M. Carroll. The title of the article is "Remote Sensing Techniques and Their Application to Soil Science." No. 7 (Part 1) covers photographic sensors and No. 8 (Part 2) covers non-photographic sensors. This is an excellent survey of published reports about the application of remote sensing techniques to the field of soil science.

D. M. Carroll concludes that panchromatic photography is generally the most useful in soil mapping. Some studies show that various color photography has advantages for some specific uses and disadvantages for others. Few had any significantly greater overall qualities than panchromatic. All involved greater initial costs and considerably greater control Ln exposure and processing. A few studies indicated use of color photography facilitiated interpretation accuracy and speed, usually for a few selected qualities, compared to psnchronatic.

The non-photographic sensor techniques probably offer greater potential but have been less thoroughly evaluated. Many of the techniques using the electromagnetic spectrum are still in the early stages of development. Much refinement is needed to approach practical consideration for use in detailed soil mapping operations.

The Laboratory for Applications for Remote Sensing, Purdue University, West Lafayette, Indiana, has done work with ERTS multispectral imagery in relation to soil maps. Results of these studies are reported in various LARS Information Notes. A representative one is "Mapping Soil Associations Using ERTS MSS Data," LARS Information Note 101773, 1973, by J. E. Cipra.

The SCS has recently accelerated contracting aerial photography specifically to obtain optimum quality panchronatic photos for soil mapping and publication. This will greatly reduce the dependency on aerial photos originally taken for other purposes and that have often lacked desirable qualities for soil mapping. Additionally, orthophoto maps significantly facilitate the publication of soil surveys by providing a planimetrically accurate base. Stereoscopic interpretation is not possible with orthophoto maps, and additional photos are necessary to obtain stereo analysis capability. These are being used to a greater degree in the soil survey program.

The committee has not been able to compile data that would substantiate clear-cut advantages of color photography or non-photography imagery sufficient to substitute for good panchronatic photography in the soil survey program. There are definite advantages in some phases of non-panchromatic remote sensing techniques that have very good potential as a supplement for specific purposes. These offer opportunities for improving accuracy and accelerating soil surveys.

Some testing and evaluations of various techniques as applicable to field soil survey operations has been and is being done by SCS and various cooperators. To date not much has been well documented and published. There is a need to evaluate and test promising new remote sensing techniques geared to field soil survey operations. Some material for this testing is available at modest or no cost.

Recommendations

1. The National Cooperative Soil Survey should continue to assess possible application of non-panchromatic and non-photographic imagery in all phases of the soil survey program. This would include field soil mapping, soil interpretations, and compilation of special purpose maps where soil information collected by current procedures is supplemented using other remote sensing techniques.

2. Means should be implemented within the NCSS to coordinate testing of new remote sensing techniques specifically for soil surveys. This should include evaluating potential areas, planning operations, evaluating results, and documenting conclusions. Testing will be done, as it is now, when opportunities arise. Fragmentation, incomplete testing, and duplication can be greatly reduced by coordination.

3. An inventory of recent and current testing being done jointly with operational soil mapping should be completed and made available. The inventory should be periodically brought up to date.

C. Field Mapping Operations

Significant advancements have been made in processing soil survey data for developing interpretations, map compilation, and manuscript preparation and publication. The committee feels that continued attention should also be directed toward advancing soil survey field procedures and operations. As the committeeis composed of a relatively broad cross section in the soil survey program so are the suggestions identified, It is well recognized that all are not universally adaptable but the concensus is that most are not sufficiently utilized where they are applicable. Where they have potential value their application should be encouraged.

1. Utilize well-planned investigative activities before and during soil survey mapping to more fully understand relationships of soils to other related resources and features, such as geomorphology, geology, water, and vegetation. This should include evaluations and documentation of the responses of soils to various uses. Greater use of the soil survey laboratory and field investigation staffs along with other related professionals should be encouraged.

2. Increased use should be made of power or specialized equipment to speed mapping and improve quality and quantity of observations. Various kinds of power and specialized equipment are of proven value in support of field soil survey operations. Parties in some survey areas where the use of this equipment is applicable are not taking advantage of the potential benefits. Where evaluations indicate a potential benefit, its purchase or rental should be encouraged. Statewide and areawide sharing of large equipment can also be done where local needs are not sufficient and rental is not feasible. Suggested equipment that has proven valuable include:

   a. Backhoes facilitate observations and the collection of soil descriptions and samples. Backhoes of various sizes and degrees of mobility are available. These have proven especially helpful where hand digging is difficult and time-consuming.

   b. Power probes and power augers have benefits similar to backhoes. They have greater mobility and can make more rapid but somewhat more restricted observations at each site. Although power probes and augers cannot be universally used in many locations as a primary soil mapping tool, there are many areas where their use as a supplemental tool will facilitate soil survey. In open country, this equipment is well suited for transecting to determine composition of mapping units.

   c. Portable power shovels driven by an electric generator have proven useful to Forest Service soil scientists in the southwest. They are most useful in areas inaccessible by other power equipment but have also proven worthwhile in more routine work.

Where hand digging for soil investigations is extremely difficult, power shovels have reduced digging time by one-third or more. The generator is carried in the bed of a pickup truck and connected to the power shovel by a long cord. cost is $1,200 to $1,400 depending on accessories. The package is put together with readily available standard components.

d. Trail bikes and other highly mobile off-the-road vehicles have been successfully used in rough areas inaccessible by more standard autos and trucks. Many of these are easily towed or carried to the area of use.

e. Portable tape recorders for note keeping for mapping unit descriptions, soil landscape relationships, soil descriptions, and soil use response information. Size, quality, versatility, and reliability have improved and increased their usefulness.

3. In addition to equipment, the employment of science aids for assisting with the routine soil survey activities have proven to be wall worthwhile. Some have become capable of completing soil mapping in non-complex areas.

There is a greater immediate need for soil survey information than can be completed. Continued efforts are encouraged to find ways to improve both quantity and quality of soil surveys to satisfy user needs.

V. G. Link, Chairman
G. A. Nielsen
J. E. Witty
J. A. DeMent
B. Birdwell
L. D. Giese
R. L. Guthrie
C. A. McGrew
L. P. Wilding
J. B. Fehrenbacher
J. A. Ferwerda
R. C. Carter
F. M. Scilley
J. W. Hawley
0. D. Bockes
T. E. Fenton
L. J. Bartelli, Advisor

Committee
for
Waste Disposal on Land

At the National Conference, it was suggested that the emphasis of Committee NO. 3, *Waste Disposal on Land", be redirected toward the disposition rather than the disposal of wastes.- The suggestion was made during the presentation of the committee report to the conference. This report is attached as Appendix 1.

Dr. Lindo J. Bartelli raised a question concerning the assumptions on which the "Interim Guide" is based. The following is a summary of the discussion which ensued.

Bartelli - We should consider using soil as a treatment medium rather than a disposal medium. Consider the soil's effectiveness in taking cars of the biological and other problems. Consider use of unsaturated flow (Bouma's work). Incorporate new criteria for testing.

Flach - Suggest this be included as a recommendation.

Wertz - Think that there is a need for consideration of both treatment and disposal.

Grossmann- The use of soils for such purposes involves matter of public health. Developemnt of criteria and any testing should include ARS representation.

Rourke - Who should have the responsibility for the development of this new guide?

Bartelli - Regional work groups should develop proposals and furnish these to the National Committee. Sanitarians should have an input in these proposals.

Flach - ARS has some expertise but responsibilities in matters of health lie with the state.

Rourke - The recommendations of Committee No. 3 will bs changed to reflect the various points made during this discussion. Regional committees will be required to develop proposed guidelines in terms of using soils as a treatment medium for biodegradable liquid-wastes and soilds and send these to the National Committee. They will also be requested to include in their membership representatives from those agencies who have expertise in and are concerned with the subject matter.

Flach - Raised a question on furnishing guidelines to the Regional Committees.

Bartelli - Outline the objectives to the committees and let them develop the guidelines.

Recommendations

1. Soils be considered as treatment medium for the disposition of biodegradable wastes rather than simply as a disposal medium.

2. Guidelines be developed, through recommendations from Regional committees, for rating limitations of soils for use as a treatment medium for the disposition of wastes.

3. The recommendations from the Regional committees should be sent to the National Committee for use in the development of an "Interim Guide" for testing.

4. The guidelines be specific in terms of the soil properties selected as significant to the use of soils for waste disposition and the limitations ratings assigned to these properties.

5. Flexibility in the application of the guidelines be permitted at the state level where the interpretations are presented in terms of soil suitability of soil potential.

6. The National Committee be continued in order to receive proposals from the Regional committes, develop an "Interim Guide," and present it for discussion at the 1977 National Work Planning Conference.

APPENDIX 1

Mr. Chairman:

The report of Committee No. 3, 'Waste Disposal on Land," of the 1975 Soil Survey Conference was reviewed by the Chairman of the committee with each of the four discussion groups. He indicated the two charges given to the committee by the Steering Committee of the National Conference.

1. Review the "Guide for Rating Limitations of Soils for Disposal of Waste" for adequacy and suggest improvements.

2. Establish the need for additional rating criteria for specific kinds of wastes and develop guidelines.

Three of the regional soil survey work planning conferences had committees (See Appendix 2 for a summarization of the recommendations from these committees.) with titles similar to Committee No. 3. Based on a recommendation from the Northeast committee that "The Head, Soil Correlation Staff of the Northeast Technical Service Center determine to what extent liberties can be taken at the state level with regional and national ratings", the Chairman of Committee No. 3 requested the members of the committee to consider two additional questions.

1. Should the guidelines be general or specific?

2. If specific, as presently written, what flexibility should be permitted in the application of those situations where the guidelines must be tempered by state laws?

Although a "Guide for Rating Limitations of Soils for Disposal of Waste" has been developed, not all soil scientists agree on the use of soils for disposal of many kinds of wastes. They point out there is a lack of under-' standing of the consequences of waste disposal, especially the biological recycling of some trace metals in wastes. All four discussion groups considered the question, "Should the National Cooperative Soil Survey try to establish guidelines for the use of soils for waste disposal." It was pointed out that we - the National Cooperative Soil Survey - are being requested by units of state and local governments and by planning agencies to provide information on the use of soils for waste disposal. If we - soil scientists - do not provide the answers, others who are far less qualified will. Recognizing that we did not have all the data, at this time, that we would like to have and should have, the discussion groups were in agreement that the National Cooperative Soil Survey should develop guidelines for the rating of soils for waste disposal. These guidelines will be changed as the result of testing demands and as new data becomes available. They should be guidelines in the strict sense of the word. They should be predictions of soil behavior and should be presented in terms of degrees of limitations. It is important to remember that we are rating only the soil component of the complete system. We must recognize that a complete systems approach for waste management is essential and this requires integrated efforts from other disciplines.

Charge 1. Review the "Guide for Rating Limitations of Soils for Disposal of Waste" for adequacy and suggest improvements.

Although the committee members were of the opinion that the Guide is a sound piece of work and that it incorporates much of what is known about soils as a waste disposal system, the Guide should be tested further.

Recommendation

1. The interim "Guide for Rating Limitations of Soils for Disposal of Wastes" dated April 27, 1973 be tested nationally. Each of the four principal soil correlators, in cooperation with state soil scientists and representatives of the cooperating agencies will assess the adequacy of the soil properties selected as guide criteria by rating selected soils in their respective areas of responsibility. The kind of waste disposal for which the soil is being rated will be indicated. The soils selected for rating till be representative of the contrasting soils occurring in the state. The ratings should be sent to the Director, Soil Survey Interpretations Division, SCS, by July 1, 1975.

2. The soils rated under Recommendation 5 will also be rated using state and local criteria, if such exists. The kind of waste disposal for which the soil is being rated will be indicated.

   These ratings should also be sent to the Director, Soil Survey Interpretations Division, SCS, by July 1, 1975.

   Nitrogen is probably the single most important element considered in the Guide. The assumption that one-third of the applied nitrogen will be lost by volatilization, fixation, or denitrification is critical and as good an estimate as can be made now. The recommendation that the annual nitrogen additions be one and one-half times the nitrogen used by the crop deserves more discussion than it has been given.

Recommendation

Page 9. Line 12 . ..1½ times the amount removed by crops can be tolerated. "If manure is the only kind of nitrogen added a constant amount should not be added each year. Instead application rates should decrease with time in order to take into account the gradual increase in mineralization as the residual organic nitrogen in the soil increases (14a). For example, in order to maintain a mineralization rate of 130 pounds of nitrogen/year using manure of 1.5% nitrogen, 429 pounds of nitrogen would need to be added the first year, 309 pounds the second year, 275 pounds the third year, and decreasing amounts down to 170 pounds the twentieth year". Reference is Pratt, R. F., F. E. Broadbent, and J. P. Martin. 1973, "Using organic wastes as nitrogen fertilizers, "California Agriculture, Vol. 27, No. 6, pages 11-12.

One of the problems in manure from feedlots in the West is sodium and not nitrogen. The permissable application rates will also include a consideration of sodium.

The assumptions used in developing Tables 1 and 2 are not stated. What guided the rationale for the breaks between slight, moderate and severe for each of the parameters listed in the Tables?

Recommendation

The assumptions used in developing Table 1 and Table '2, i.e., the rationale for the breaks between slight, moderate, and severe for each of the parameters listed in the tables, be clearly stated.

Tables 1 and 2 may have to be treated differently for different kinds of wastes depending upon their composition. For example, separate tables may have to be developed for highly nitrogenuous wastes. It is becoming clearer that poorly drained soils may be superior to well drained soils for reducing nitrogen contents by derdtrification. There may be some reluctance to suggest spreading wastes in wetlands areas but the fact that denitrification may become the most important pathway to reduce nitrogen contents of wastes and it works best in poorly aerated soils cannot be altered. Perhaps the interpretations may suggest the kinds of upland soils that could be artificially converted to a denitrifying environment by addition of excess water and alteration of the C/N ratio. Perhaps this suggests that separate tables should be prepared for more specific kinds of wastes rather than the two broad types developed for liquid and solid wastes.

Recommendations

1. A list of the different kinds of waste to be considered in the guide be compiled.

2. Definitions of toxic, non-toxic, biodegradable and non-biodegradable wastes be developed with other agencies, such as ARS, USGS, Experiment Stations, EPA, HEW, etc., for inclusion in the guide.

3. After wastes have been defined and list compiled, re-examine Tables 1 and 2 to determine the need for the development of guidelines for specific kinds of wastes.

Other Recommendations concerning Tables 1 and 2.

1. Change the title of the first column of both Table 1 and Table 2 from "Item Affecting Use" to "Soil Property Affecting Use".

2. "as a water table that limits plant root growth" be added to Footnote 6 on Table 1 and to Footnote 5 on Table 2.

For Table 1,the parameter on flooding should reflect severe limitation for any flooding irrespective of growing season or non-growing. Although flood plains are normally thought to be landforms of deposition, soil that has adsorbed nutrients may be subject to some erosion and resolution during prolonged flooding. Nutrients move to adjacent water bodies in solution or adsorbed on soil particles and contribute to eutrophication.

Recommendation

The parameter on flooding should have a severe limitation for any flooding irrespective of growing season or non-growing season.

Application rates where the minimum water is used for maximum production is a common irrigation principle; any water application beyond this point is a high application rate. In most disposal systems, the object is to reclaim the maximum water, with or without workable production, using the same principles of soil and crop filtration, biological activity and uptake or immobilization of minerals.

Recommendation

The reference to low application rate be deleted from Table 1 and from the explanatory text.

For Table 2, some members of the committee felt that the parameter on flooding should distinguish between manure that was plowed under within a reasonable time after application or allowed to remain on the surface. This interpretation would bring an element of management into the interpretation.

Recommendation

The parameter on flooding be changed as follows:

Slight - None.

Moderate - Soils flooded - manure plowed under.

Severe - Soils flooded - manure not plowed under.

Other Recommendations

1. Page 2. Add "Toxic materials" and "Pathogens" to the list of "constituents and properties of waste discussed."

2. Page 3 Slope classes and classes of stoniness and rockiness be added to the list of soil properties considered in rating the soils. These three properties affect the ease of using machinery to get the wastes on the land.

3. Page 11. Line 3 from the bottom

Add after "...original waste," "The trace element content of the soils should be examined after a few decades of use of the site for waste disposal. If there is evidence that trace elements accumulate, the site will need to be abandoned before the trace element content reaches toxic levels. This possiblity should be considered in the initial plans for the operation." "Sludge may...

4. Page 11. Line 2 from the bottom. After "closely spaced ditches" the following be added "as may be composted and then spread on the land."

5. Page 24. Table 5, Footnote 1

After line 1, add, " if manure is the only source of nitrogen added, constant annual application rates are not recommended. See discussion on page 9." "Lower limits...

Charge 2. Establish the need for additional criteria for specific kinds of wastes and develop guidelines.

Not all of the committee members responded to this charge. One member commented as follows: "We will continually have to develop new interpretations and revise old interpretations for use of soils for waste disposal as experience, technology and research data indicate. The composition of industrial wastes 20 years from now may be different from those we now have. At present, at the national level, develop guidelines for the major kinds of wastes. At lower governmental levels we should be able to develop guidelines for disposal of wastes unique to an area or region."

Several committee members concurred with the recommendation by the Southern committee that a guide be developed for the disposal of wastes through overland runoff systems.

Recommendation

A separate table be developed for reclaiming waste water by overland runoff or orverland flow.

Charge 3. Should the guidelines be general or specific?

All of the committee members responded to this charge, and most did so to some length. If the chairman has interpreted their comments correctly, the committee is about equally divided in its opinion as to whether the guidelines should be general or specific. The chairman has taken the liberty of using the comments, verbatim, from seven of the members to summarize the two opposing opinions.

The Guideline Should Be General

"It is necessary to consider the criteria, developed nationally to guide the preparation of soil interpretations, as guidelines, not rigid rules; in my opinion this is our only reasonable choice. There are too many variables that impact on ratings within portions of states or groups of states that cannot be properly dealt with in standards written for rigid national application.

" We might attempt to identify a set of those soil properties that are of such broad influence on waste disposal that they could be used nationally, and a separate set of factors for which narrower use is indicated. Frankly, we are not sure that such an effort would be helpful, namely because all of our single factor rating guides tend to breakdown because of the interactions of influential soil properties. For example, a somewhat poorly drained soil with rapid permeability might have severe limitation in a frigid area of high rainfall and a slight limitation in a thermic area of moderate or low rainfall. This may be a poor example, but it illustrates the problem.

"The rating guides provide a basis for assuring consistent rating of soils within given counties or portions of states. Increasing the size of the area tends to decrease the extent to which rigid application is possible. We certainly want to rate a given kind of the soil the same throughout its area of occurrence, and to rate similar soils the same throughout the country. However, depending on the set of assumptions about what it is that makes soils 'similar', we may find that not all properties influencing a given use are among those serving as a basis of similarity, nor, on the other hand, are they necessarily among those chosen as rating criteria.

"If we had extensive data for all soils regarding their performance when all the various kinds of wastes were applied in varying amounts, then obviously we wouldn't need rating guides, except perhaps to test the need to subdivide series for which the range in performance was too wide. The rating guides are needed because we don't have the data. But we are likely to find that our current guides result in ratings that are not compatible with local observations of performance -- once we get the vital information. Such data may clearly justify departure from national guidelines, and quite naturally in their eventual revision. Thus, establishing rigid national rating criteria is not a logical approach."

The Guides Should be Specific

"We believe that the national guide should be specific, regarding the 'Soil Properties Affecting Use.' These soil features should be based on research and experience, and it is difficult for us to see that any local variance should be needed or necessary if adequate data supports those soil features that are listed and their influence on use. (Someone may think of a good reason for variance, however, it escapes me at the moment.)"

"I believe we need a national guide. I also believe we need a potential type guide where the weighting of soil characteristics affecting the problem can be done locally to rate the soils for a county or multicounty area. Nrst let us realize that the guides we make are imperfect because we do not use all soil characteristics and their effect on each other. We use only certain "significant" characteristics and weight within characteristics, but not between characteristics. An example is Table I in SCS Advisory Soils -14 where there are three breakdowns of permeability for slight, moderate, and severe, but no weighting between permeability, runoff, flooding, etc.

"We do need a policy on how to use the guide. I believe we need to follow the guide to be able to get any uniformity and to achieve coordination. Otherwise, certain states would manipulate the guide to show the best soils in their areas slight, even though they should rate moderate on the national scale. We have had enough experience with this situation to see no other alternative. But the guide should not be used to place a soil in the wrong rating. If the soil should be slight, but the guide keys it out to be moderate, the guide should be altered to make the soil come out in the right place. But it must be altered at the national level so that everyone will have the information, and not altered 50 different ways where the guide is no longer a national guide.

"The problem here is that new guides are often developed by testing. The wildlife guide did not work very well in some areas. If it had been followed to the letter, some soils would have been placed in the wrong rating. We did allow some variation in this guide until it was developed further. I do believethe guide should be specific; otherwise, it would effect little uniformity and there would be little incentive for revision."

"Yes, specific in the sense that they are technically correct and based on latest research data and techniques. The guidelines should be in terms of soil limitations and be a guide for rating soils for suitability for waste disposal, i.e., frigid soils may have a moderate limitation for disposal of wastes, but may be considered a suitable soil in the region of their occurrence, especially so if managed to overcome limitations."

Recommendation

The guidelines be specific in terms of the soil properties selected as significant to the use of soils for waste disposal and the limitation ratings assigned to these properties.

Charge 4. If specific, as presently written what flexibility should be permitted in the application of the criteria in those situations where the guidelines must be tempered by state laws?

Some of the committee members felt that flexibility in the guidelines may be needed or may be appropriate. This would be achieved as follows:

"Flexibility in the guidelines may be needed at the state level in the "degree of Soil Limitations," as pointed out by the NE Committee. I believe this flexibility could be approved by the Head, Soil Correlation Staff after reviewing adequate supporting evidence from the state."

"Some flexibility is appropriate, but no state should alter the guidelines unless they have field and/or laboratory data to support the changes they make. Any state making such local changes needs to keep the TSC and Washington offices informed of the changes and the reasons."

One committee member commented as follows:

"No real problem if we use the 'new' soil suitability concept. Soil limitations are based on soil properties. State laws may permit use of soils with severe limitations if certain design and construction criteria are met."

Recommendation

Flexibility in the application of the guidelines be permitted at the state level when the interpretations are presented in terms of soil suitability or soil potential.

It is also recommended that the committee be continued.

Committee Members

John D. Rourke, Chairman........... SCS, NE TSC, Upper Darby, Pennsylvania
George Holmgren, Vice Chairman .... SCS, Lincoln, Nebraska
O. F. Bailey .... SCS, Honolulu, Hawaii
C. Reese Berdanier, Jr. .... SCS, Lincoln, Nebraska
J. Bouma .... University of Wisconsin, Madison, Wisconsin
B. L. Carlile .... N. C. State Univ., Raleigh, North Carolina
J. H. Ferwerda .... SCS, Orono, Maine
C. E. Fogg .... SCS, Washington, D. C.
F. Harner .... SCS, East Lansing, Michigan
A. R. Hidlebaugh .... SCS, Washington, D. C.
P. R. Johnson .... SCS, Lincoln, Nebraska
R. W. Johnson .... SCS, Gainesville, Florida
L. N. Langan .... SCS, TSC, Portland, Oregon
D. E. McCormack .... SCS, Washington, D. C.
W. D. Nettleton .... SCS, Riverside, California
J. D. Nichols .... SCS, TSC, Fort Worth, Texas
K. W. Flach, Advisor .... SCS, Washington, D. C.

APPENDIX 2

Northeast Soil Survey Work Planning Conference
Committee 2 - Use of Soils for Waste Disposal

Charge 1. Development of regional guidelines for using and interpreting the use of soils for disposal of wastes and review of interim national "Guide for Rating the Limitations of Soils for the Disposal of Waste."

Development of guidelines

In developing guidelines for the use of soils for waste disposal, we assume that the soil is one way to dispose of various kinds of wastes. But it is well to remember that not all soil scientists agree on the use of soils for disposal of many kinds of wastes for there is a lack of understanding of the consequences of waste disposal, especially the biological recycling of some trace metals in wastes. Long term observations in this country are scant. With the exception of farm manures, our experience is relatively short. Researchers througout the country have shown that certain kinds of solid and liquid wastes can be degraded and stabilized without apparent harm to the environment. But what about the long pull? How long can wastes be applied to a site before the capacity of the soil to fix or immobilize various constituents in wastes is exceeded? Our lack of long-term knowledge in some areas may cause some misdirection in waste management for no one can fully predict all interactions between the waste and the soil to which it is applied. At best, soil scientists should proceed with caution in their advocacy. Further, areas of soils that meet the requirements as waste disposal sites have many properties in common with our agriculturally productive soils and they do not constitute a" unlimited national resource.

The first question for discussion was whether guidelines should be prepared at the national or regional level or should they be developed at the state level guided by local factors and tempered by state law. In several cases, soil limitation ratings for septic tank drainfields were not compatible with state regulations. Variances from national interpretations as set forth In the national "Guide for Interpreting Engineering Uses of Soils" were cited for Connecticut and Pennsylvania. I" Pennsylvania, for example, soils with percolation rates less than 6 min/in are rated severe because of poor renovation of effluent. In the national guide rates faster than 45 min/in are rated slight but footnoted to indicate possible pollution hazard. In Connecticut, rates 30-60 min/in are deemed moderate because a professional engineer is required to design the system and it is proposed that he supervise and certify its installation. After much discussion the committee recommended the following:

RECOMMENDATION: The Head, Soil Correlation Staff of the Northeast Technical Service Center should determine to what extent liberties can be taken at the state level with regional and national criteria ratings. Local variances would have to be supported by local information showing that national or regional guidelines are not applicable.

I" view of the possible conflicts between national guidelines already developed for use in some aspects of waste disposal and guidelines that will be developed for the Northeast Region, the committee felt it premature to develop the guidelines for this conference.

The committee agreed to consider guidelines for the following kinds of wastes:

1. Animal wastes.

2. Effluent from sewage treatment plants.

3. Effluent from septic tanks.

4. Sewage sludge.

5. Solid wastes in sanitary landfills including interpretations for soil host, soil cover, and leachate collected for soil treatment.

The committee felt that although most industrial wastes are problems unto themselves, they cannot be ignored if soil can be used to stabilize them. Industrial wastes may reach the soil by two pathways: 1. those discharged to sewage treatment plants and accidently or intentionally contributing to the chemical behavior of sewage treatment plant effluent, and 2. those treated by other means to change their form before disposal.

Review of "Guide for Rating Limitations of Soils for Disposal of Waste"

In response to the request to review and offer recommendations for improvement of these national guidelines, the following are suggested.

1. I" Tables 1 and 2, relax the restrictions in Footnote 1 assigning "no better than moderate" limitations for regional interpretative groupings to mesic soils. Regional interpretations should be based on the best available soils for waste disposal. It cannot be denied degradation rates in mesic soils do not compare with rates in thermic soils but in the absence of thermic soils regionally, mesic soils are the best we have and should receive slight limitations. Wastes will not be exported to thermic regions to take advantage of faster degradation rates. For mesic soils, adjustments can be made in rates of application.

2. Tables 1 and 2 may have to be treated differently for different kinds of wastes depending upon the composition of the waste. For example, separate tables may have to be developed for highly nitrogenous wastes. It is becoming clearer that poorly drained soils may be superior to well drained soils for reducing nitrogen contents by denitrification. There may be some reluctance, however, to suggest spreading wastes in wetlands areas. Perhaps the interpretations may suggest the kinds of upland soils that could be artificially converted to a denitrifying environment by addition of excess water and alteration of the C/N ratio. Separate tables may be prepared for more specific kinds of wastes rather than the two broad types developed for liquid and solid wastes.

3. For Table 1, the parameter on flooding should reflect severs limitation for any flooding irrespective of growing season or non-growing. Although flood plains are normally thought to be landforms of deposition, soil that has adsorbed nutrients may be subject to some erosion and resolution during prolonged flooding. Nutrients move to adjacent water bodies in solution or adsorbed on soil particles and contribute to eutrophication.

For Table 2, some members of the committee felt that the parameter on flooding could distinguish between manure that was plowed under within a reasonable time after application or allowed to remain on the surface. This interpretation would bring a" element of management into the interpretation and result in the following:

Slight - None

Moderate - Soils flooded - manure plowed under

Severe - Soils flooded - manure not plowed under

4. The committee felt that the assumptions used In developing Tables 1 and 2 should be clearly stated. What guided the rationale for the breaks between slight, moderate, and severs for each of the parameters listed in the tables?

5. In the narrative under "Management Guide" there wassome disagreement voiced that the quantities of waste that provided one and one-half times that which would be used by a crop were not enough under certain circumstances. This is based on the assumption that one-third nitrogen will be lost by volatilization. Studies in Connecticut have show" that liquid animal waste slurries spread thinly over the ground will lose up to one-half of its nitrogen by volatilization. Thus if a crop requires 150 lb/acre nitrogen it will require twice that be added to offset volatilization losses unless it is plowed under immediately. To fully compensate for volatilization losses, crop utilization, and very slow release of part of the nitrogen tied up in the manure, then a factor of two and one-half could be used for application rates of liquid animal wastes.

6. In the narrative "Biological Impact of Some Elements" the statements on the toxicity of chromium need clarification especially the availability of valence forms of chromium. Although chromium toxicities can be produced in the laboratory, evidence that it has caused toxicity in the field is not conclusive.

Charge 2. Enlist help of geologists, hydrologists, sanitary engineers, and others in developing these guidelines.

Development of complete systems approach to waste management

In discussing Charge 2 that sought to enlist the assistance of geologists, hydrologists, and sanitary engineers in developing guidelines, the committee felt that it should concentrate its efforts on guidelines for soils only. It recognized, however, that a complete systems approach for waste management is essential and this requires integrated efforts from other disciplines. Guidelines that interpret soils for waste disposal must take into consideration three bodies of knowledge: 1. the physical, chemical, and biological properties of the waste; 2. the physical, chemical, and biological properties of the soil to which the waste will be applied; and 3. the interactions between waste and soil to understand the stabilization of the waste and the mechanisms of attenuation of potential pollutants as they move from the disposal site. Each potential pollutant must be assessed differently for their rates of attenuation and stabilization are vastly different. we must fully understand such mechanisms of attenuation as dilution by rainfall, dispersion in ground water (diffusion, density gradients), cation exchange, fixation (precipitation, chelation), volatilization, biological utilization and transformation and mechanical filtration. A complete systems analysis would include consideration of the following parameters and perhaps others:

Landscape: slope, depth to bedrock, aspect, land cover.

Climate: rainfall, evapotranspiration.

Hydrology: depth and duration of water tables, saturated thickness of aquifer, transmisability under saturated flow, ground water quality.

Soil:

Physical - permeability, texture, textural discontinuities, temperature

Chemical - pH, CEC, base saturation, free iron and aluminum content, organic matter

Biological - enzymatic activity of resident soil organisms, aerobic or anaerobic system.

Guidelines prepared for soil interpretations should include a statement that other factors require investigation. Some of these parameters deal with the environment, others do not. These fall into the realm of economics and politics.

If guidelines take on a quantitative aspect and recommendations are made on application rates of waste we can consider three different rates. 1. a safe sustained utilization rate using the waste as a soil ammendment in crop production . This rate should not injure the crop or render it useless as a feed; 2. a safe maximum disposal rate applied annually that will not degrade the environment; 3. a safe disposal rate applied one time only.

Charge 3. Develop a list of references for each of several kinds of wastes.

Development of reference lists

Development of reference lists is a herculean task. Good use should be made of existing reference lists and abstracting services. For current research a the CRIS program can identify and compile if fed the proper key words. An abbreviated list know" to committee members who responded is found in the Appendix to this report.

Charge 4. Suggest research needed.

Research needs

1. Long-term studies are needed that will assist in determining the longevity of waste management and disposal systems.

2. Studies of interactions between waste and soil. We not only need to know what effect the soil has on the waste but what effect the waste has on the soil. The latter may be helpful in anticipating the longevity of waste disposal in soil.

3. Heavy metals in effluvent and sludges merit considerable attention for they may present health hazards if used in crop production systems. It is important to better understand the capacity and mechanisms of storage, resolubility due to changes in pH or redox potential, and release during decomposition of organic matter.

The committee recommended that it be continued as a working committee to prepare waste disposal guidelines.

Southern Regional Soil Survey Work Planning Conference - Committee 1 - Wastewater

Reclamation and Disposal by Land Spreading

Charge 1. What changes or additions would improve the "Interim Guide for Rating Limitations of Soils for Disposal of Waste."

Suggested changes or additions to interim guide:

1. Waste should be defined in the first paragraph to avoid confusion with the kind of waste put into a sanitary landfill. This can be done by wording to exclude junk, garbage and trash.

2. Low application rates and high application rates were a point of much discussion. Application rates where the minimum water is used for the maximum production is a common irrigation principle. Many committee members felt that any water application beyond this point was a high rate system. In most disposal, the object is to reclaim the maximum water, with or without marketable production, using the same principles of soil and crop filtration, biological activity and uptake or immobilization of minerals. All recognized, however, this should not be confused with hydraulic loading or rapid infiltration systems where the soil is used only as a" entrance medium for disposal by underground recharge.

3. Further study by the committee indicates the items affecting use are essentially the same for irrigating soils and growing plants regardless of maximizing production or maximizing water reclamation. For these reasons,

we recommend Table 1 in Advisory Soils-14, as well as the text explaining the table, omit reference to low rate. Table 1 should reflect the use of soil for reclaiming wastewater by irrigation where the soil acts as a filter, in addition, to supporting plant growth.

4. We recommend that a separate table be developed for rating soils for reclaiming wastewater by overland runoff or overland flow.

5. Infiltration rate, though quite important, is not presently expressed to serve at arriving at a limitation rating. The application intake rate would be most valuable, however this is not available for most soils of the Southern Region. We recommend infiltration rate be deleted from Table 1.

6. Ratings soils for "flooding only during non-growing season" will require more than pedological data, and may involve a design using winter or summer crops as appropriate. We recommend Table 1 be changed to read "severe - soils subject to flooding."

7. Temporary vs permanent installation seems to relate more to design than to soil limitation for reclaiming wastewater. We recommend both be deleted from Table 1 and retain available water capacity as "slight > 7.8 inches, moderate 3 to 7.8 inches, and severe < 3 inches."

8. The committee recommends three additional items affecting use be added to Table 1.

	Slight	Moderate	Severe
a. Depth to water table	> 60"	30-60"	< 30"
b. Depth to bedrock	> 60"	40-60"	< 40"
C. Slope	< 5%	5-12%	> 12%

In addition, change flooding to "moderate-none, severe-subject to flooding."

9. The items affecting use for irrigation with soil as a filter, Table 1 of Advisory Soils-14, are essentially the same as for solid wastes, Table 2. For this reason, we suggest the tables be combined.

Charge 2. How can this guide be better related to taxonomic soil groups?

Most of the items affecting use are directly related to soil families. To relate best to taxonomy, the use of cognate groups would be most helpful in developing a guide. After the significant items affecting use are determined, a second or additional guide can be developed related to taxonomy, as well as the lowest possible level such as phases of series.

Charge 3. What short range testing can be done, and what are the long range investigation needs?

1. Short range testing could be done on a few benchmark soils using the criteria of the national guide. Judgments by those who know the properties of the selected soils may lead to refinements of the guide.

2. For the most part, problems encountered in disposal by land spreading ..ot lend themselves to short range testing. An investigation of on-going systems with national criteria, or revised criteria in mind would help to identify the desirable soil parameters and taxonomic soil groups most effective for waste disposal.

3. Long range investigations should be concentrated on irrigating to maximize water reclamation through the use of both soil end plants as a filter. This area has the greatest lack of predicted response, and because of growth pressure is receiving the most attention as a disposal method.

4. Disposal sites on extensive soils should be monitored, and data used to develop and refine the guide for high application rates. Groupings should be made of soils with similar behavior.

Recommendations

1. Omit reference to low rate system and define in text and table for maximizing water reclamation by irrigation with the soil as a filter.

2. Develop a guide for rating soils for maximizing water reclamation overland runoff or overland flow.

3. Modify present Table 1 by omitting infiltration, temporary and permanent installation, and by adding depth to water table, depth to bedrock and slope.

4. Combine tables for liquids and solids.

5. The present guide does not consider the effect of moisture surplus areas as compared to moisture deficient areas and the relationship with other items affecting use, such as available water capacity, permeability and runoff, We recommend new guides be prepared by major moisture regimes, such as udic, ustic, aridic.

6. Limitation ratings are not enough; we need to highlight the problems that can be overcome by design, and show the potential after treatment or installation.

7. Locate by mapping procedures those soils on broad landscapes where waste disposal by land spreading might best be suited. Place a high priority on mapping these soil areas in close proximity to the municipalities where land spreading may be needed.

8. Many states have specific laws in effect prescribing various criteria relating to liquid and solid waste disposal. These laws are not similar in each state, and regardless of a uniform soil interpretative guide, the specific state regulations must be considered. It might be useful to summarize existing laws and regulations for incorporating into a soil interpretative guide for the Southern Region.

The committee recommended that it be continued.

Western Regional Soil Survey Work Planning Conference - Committee 3 - Waste Disposal on Land

Charge 1. Review the "Guide for Rating Limitations of Soils for Disposal of Waste."

Recommend any amendments, deletions or additions.

Comments and recommendation:

Table 1: Use following to replace Soil Drainage Class criteria:

	Slight	Moderate	Severe
Depth to Seasonal Water Table (1 month or more)	40"	20-40"	20"

In Table 1, the Sodium Absorption Ratio of the effluent being applied needs to be considered for the influence of this factor on infiltration rate. The table should reflect combined influence of the texture or base exchange capacity of the surface horizon.

Flooding should be expressed in terms defined for Form SCS-SOILS-5.

Rather than designate mesic soils as having a moderate limitation, several states would prefer that mesic soils with long growing seasons be designated slight. The infiltration rate needs better definition before it can be used consistently. Past use or treatment of soils strongly influence infiltration rates.

Table 2:

Consideration for wind erosion hazard is pertinent to the disposal of some solid waste in soil to avoid nuisance. Same reference to Footnote 1 as for Table 1.

on page 11 add the following sentence before the last two sentencer) on the page. "The trace element content of the soil should be examined after a few decades of use of the site for waste disposal. Eventually, the site may need to be abandoned or trace element levels will reach toxic levels. This should be considered in the initial plans for the operation."

A few errors noted are:

Page 2, line 14	Other than BOD. The best soil...
Page 9, line 6	Tables 4 and 7 (pages 23 and 26) list...
Page 17, line 16	Spelling error - Element not elemt".

Charge 2. Need for additional criteria for specific kinds of waste.

1. Disposal of waste from paper mills.

2. Use of constant input approach to calculate yearly N mineralization in disposal area. As a reference, the report cited a paper by Pratt, Broadbent and Martin, titled "Using Organic Wastes as Nitrogen Fertilizers," published in California Agriculture, June 1973, pages 10-13.

Charge 3. Assess state pilot projects.

The ARS Water Laboratory in Phoenix has been involved in a study of applying municipal sewage from the city of Phoenix to soils and alluvial deposits as a potential means of sewage disposal. This project, known as the "Flushing Meadows Project" was started in 1967. The use of a plant-soil filter system (grass recharge basins) shows potential for converting secondary effluent into water satisfactory for irrigation, recreation, and even human domestic use under the right condition.

A study was recently completed at the University of Arizona to determine the feasibility of exchanging sewage effluent from the city of Tucson for groundwater from the Avra Valley. The treated wastewater would be used for irrigation in the Avra Valley and the high quality groundwater would be added to the Tuscon municipal system for domestic use.

APPENDIX 3

INFORMAL COMMENTS ON REPORT OF
COMMITTEE NO. 3, 'WASTE DISPOSAL ON LAND."
from
L. A. Wood
Water Resources Division, USGS
Transmitted by J. R. Anderson to J. D. Rourke

Criteria and guidelines for rating soils for disposal of wates should recognize that the soil zone is the gateway for water percolating to the aquifers. Waste disposal practices that exhibit no difficulties at the surface or in the soil zone may be contributing to the degradation of water resources. The soil characteristics are important considerations in waste disposal but the underlying aquifer characteristics are also very important. Soils that have infiltration rates that permit precipitation to drain rapidly may become water-logged when the annual rainfall is doubled or tripled by spraying treated wastewater. The water-table may rise into the soil from the aquifer.

A soil may effectively absorb organic compounds from a particular waste but the soil has a finite capacity and sorbed compounds may be released to the ground water by changes in waste chemistry. We have adequate knowledge about build-up of trace metals in soil, how they are sorbed, how they react with soil, how they move, and how they are taken up. Because of these and other reasons, criteria for rating soils for disposal of wastes should be used in conjunction with other geologic and hydrologic information.

Report of Committee No. 4 "Water Relations in Soils"

I. Future Efforts

The committee should be continued.

This committee worked on (1) descriptions of water status and transmission for the new Soil Survey Manual; (2) changes in Soil Taxonomy pertaining to the water regime of soils; and (3) application of hydrologic models in the soil survey. The first is topical now but should decline in importance shortly after publication of the new Manual and would not seem a useful primary topic for the regional conferences. Application of the approaches to the description of the soil water regime in the new Manual to the soil survey interpretations program would seem an important topic for future committee work.

The second topic may be better handled in the future by the regional committees on taxonomy (Advisory SOILS-26). The next national committee on soil water might ascertain from the regional conferences whether there are taxonomic questions that should be pursued by the committee. Approaches and nomenclature in the new Manual will require changes in Soil Taxonomy to make the two consistent. This may be a useful area for the next national committee.

The third matter--the application of hydrologic models--should receive major emphasis by the regional conferences. The subcommittee report herein is concerned with a particular hydrologic model. There is need to examine the common features and application of the several deterministic models under development and in use by ARS and/or EPA. ARS has under development the Agricultural Chemical Transport Model (ACTMO). A version of this incorporates the model USDAHL-74 which is discussed in the subcommittee report. The requirements for and application of ACTMO would seem pertinent to work by regional conferences on soil water, erosion and pollution.

A need both for hydrologic models and for the soil survey interpretations program generally is more emphasis on the prediction of water transmission rates. The regional conferences should focus on this aspect of soil water characterization.

Aspects of the description of soil wetness were considered in one form or another by all of the subcommittees. The proposals on extension of the pattern of soil water states for the new Manual draw heavily on ideas of workers in the southern region as expressed in the southern regional committee on soil wetness. The subcommittee on soil taxonomy herein considered modification in the current taxonomic definition of the aquic moisture regime. An unresolved question discussed at the conference is that soil wetness may not lead to the reducing conditions required for morphological expression, such as low chroma nottles. Yet this wetness is just as wet for most nonagricultural soil uses! Future regional committees on soil moisture should. consider soil wetness. Definitions on wetness in Soil Taxonomy and in the new Soil Survey Manual should be made consistent and considered against the practice and needs of soil survey interpretations.

II. Recommendations

A. Hydrologic Models

Development of hydrologic models is being actively pursued by the Agricultural Research Service (ARS), the Environmental Protection Agency (EPA), and various Experiment Station people. EPA has under development a users handbook that involves hydrologic modeling and two complete (deterministic) models pertaining to agricultural lands to be used for the prediction of pesticide movement and runoff. ARS has under development the Agricultural Chemical Transport Model (ACTMO). One version of ACTMO incorporates the model USDAHL-74, the subject of a subcommittee report.

Certain general observations may be useful in guiding increased involvement of the soil survey with hydrologic models:

Determine the major deterministic models used by ARS or EPA;

Assess the soil and landscape properties required for these models;

Evaluate whether these properties are now obtainable either directly or by substitution from the usual soil survey documentation;

Consider for those properties not now attainable whether they could be obtained through reasonable changes in field procedures and laboratory objectives.

USDAHL-74 is a successful model. It has accurately predicted soil moisture content of an Argiustoll over a 15-month period and water table changes in a watershed as a result of land treatment measures. The soil survey should further test the applications of USDAHL-74 for placement in taxonomic soil moisture regimes and other purposes. Use of HL-74 would be facilitated by more general availability of bulk density data for calculation of pore space and more information on slope length in mapping unit descriptions. More detailed observations would be helpful on the surface soil on structure, large pores and root distribution.

B. Soil Taxonomy

1. Proposals for modification of the definition of the aquic moisture regime in Soil Taxonomy that were made by the 1974 southern regional committee on soil wetness warrant further consideration and testing for possible adoption. The proposals should be submitted to the four regional soil taxonomy committees.

   To follow is the southern regional proposal for modification of the aquic regime:

   The aquic moisture regime implies a reducing regime during some part of the year. During such periods the soil water at or near the surface and in one or more subjacent horizons is virtually free of dissolved oxygen because the soil is saturated either by water of the capillary fringe or by water under a pressure equal to or greater than that of the atmosphere or a limited exchange of oxygen with the atmosphere. Water may or may not stand in an unlined bore hole at such times.

   Duration of the period that the soil must be virtually free of dissolved oxygen to have an aquic regime is not known. The duration must be at least a few days and at a time when the soil temperature is above biologic zero (5" C.).

   Some soil horizons, at times, are saturated with water which has dissolved oxygen, but such a regime is not considered aquic. Dissolved oxygen may be present either because the water is moving or because the environment is unfavorable for micro-organisms, commonly because the temperature is too low.

   The aquic moisture regime would be subdivided into three parts to accommodate the differences in saturated regimes:

   Peneaquic (pene meaning almost). Saturation is confined to the upper 30 cm, or water will not flow into a bore hole below 30 cm unless a loamy aquifer is intersected.

Epiaquic (epi meaning upper). Saturation is confined to the upper 1.25 m of the soil by a restricting layer, The water table is free to fluctuate above 1.25 m. The horizons below 1.25 m are not saturated, or water will not run into a bore hole from this depth. A water table may be encountered below 2 m. The unsaturated zone separates the upper saturated horizons from any underlying water table.

Liberaquic (liber means free). Saturation is possible throughout the soil. The water table is free to fluctuate through several meters. Temporary perching by fragipan or plinthite horizons may occur, but the zones of saturation eventually join.

C. Soil Survey Manual

1. Water State

a) Appendix 6 in the 4th draft of the new Manual which describes the drainage classes of the 1951 Manual should be deleted.

b) The term "water table" would be replaced by "free water" defined as "water that moves only under the force of gravity or positive pressure gradients".

c) The criterion for the separation between slightly moist and very moist soil water states should be changed from water content to a tension of 0.8-bar.

d) The present set of terms of soil-water states should be expanded to provide more fully for the description of the pattern of occurrence of free water. To follow are classes and terms descriptive of the depth to free water and the continuity of the free water from its upper boundary to 2 m unless observations are lacking to this depth or there is a barrier to observation, such as a lithic contact.

<u>Depth</u>

Condition	Term
Above surface	Flooded, ponded
0 to 50 cm	Shallow
0 to 30 cm	Very shallow
30 to 50 cm	Moderately shallow
50 to 100 cm	Moderately deep
100 to 200 cm	Deep
> 200 cm	Very deep

Continuity

Condition	Term
Vertically continuous	Continuous
Not vertically continuous	Discontinuous
Single zone < 50 cm thick	Thin
< 30 cm	Very thin
30 to 50 cm	Moderately thin
Single zone 50 to 100 cm thick	Thick
Single zone 100 to 200 cm thick	Very thick
Multiple zones that span a thickness as per classes for single zone	Multiple
Vertical continuity not determined or variable	Unestablished continuity

2. Water Transmission

a) Perviousness classes should be replaced by classes of vertical saturated hydraulic conductivity, referred to as "permeability". Class placement is to be based on the horizon with the minimum value for the series or other control section excluding the surface horizon.

b) The present set of permeability classes should be changed as given below. The SCS Engineering Division should be asked to review the limit of 0.0006 and to recommend an alternative if thought desirable.

in/hr	Name
> 20	Very rapid
20-2	High
20-6	Rapid
6-2	Moderately rapid
2-0.2	Intermediate
2-0.6	Moderate
0.6-0.2	Moderately slow
0.2-0.0006	Low
0.2-0.06	Slow
0.06-0.0006	Very low
< 0.06	Very slow
< 0.0006	Extremely low

c) Horizontal permeability should be estimated as a footnote to the vertical estimates in tables of values by horizon or zones if the upper limit of the horizontal estimate exceeds the upper limit of the vertical by over tenfold.

d) The equivalent metric units to inches/hour for class definitions of permeability in the new Manual would be millimeters per hour.

3. Water Retention

a) The new Manual should employ water retention difference (WRD) instead of available water capacity (AWC) as the primary descriptor. To implement this, the following guidelines for mineral soils on the lower tension to employ have been formulated which would appear in the review draft for comment:

Tension to Employ	Soil Material
0.06-bar	All coarse sands, sands and fine sands. Very fine sand, loamy sand and sandy loam that has a permeability above 2 inches/hour and occurs within 30 cm of either the upper boundary of a horizon with an assumed permeability tenfold or more below that of the zone in question, or a horizon that is either fragmental or contains less than 10 percent of < 0.1 mm as a percent of the < 2 mm.
0.1-bar	Use only if 0.06-bar is not specified. Use for very fine sand; loamy sand and sandy loam; soils in oxidic families; and all horizons with a bulk density of the fine earth of less than 1.2, irrespective of the texture.
1/3-bar	Other.

b) Available water capacity (AWC) should be adjusted from water retention difference (WRD) for interpretations. The adjustments would be determined by the crop and degree of root exploitation. Marked mechanical impedance to roots would be assumed, unless there is evidence to the contrary, if structure expression exceeding weak is restricted to units with a repeat distance greater than 10 cm, and one or both of two characteristics are found: (1) a moist fine-earth bulk density of 1.8 g/cc or more; (2) a micro-penetration resistance when wet of 5 kg or more.

III. Comments by Conferees on Recommendations

Recommendation B1

Dudal--Like this development. French and Germans consider distinction between perched and continuous water tables at a high level in their classifications.

Bartelli--Handle these recommendations through the regional committees on taxonomy. Note--This change has been incorporated.

Recommendation Cla

Dudal--Want to delete drainage discussion in Manual if inconsistent with Soil Taxonomy. If published, people would use incorrectly.

&over--Inclusion only to provide a record of what has been done in the past.

Recommendation Clb

Ralston--Should this be positive external pressure?

Recommendation Cld

Bailey--Use term "discontinuous" for "not vertically continuous". Note--This change has been made.

Fenton--Have both "Flooded" and "Ponded" to describe free water above the ground surface. Note--This change has been made.

Recommendations C2a, C2b, C2c, C2d

Daniels--Is C2a compatible with field methods, specifically the auger-hole method.

Grossman--Should not use auger-hole method for evaluation because values strongly controlled by horizons with maximum permeability and vertical orientation not specified.

Johnson--How do our permeability estimates relate to the properties of a polypedon? Can these estimates be used in hydrologic models? Need to evaluate class names in C2b.

Anderson--Is horizontal permeability limited to estimates or are measurements planned? Why use mm/hr instead of cm/hr?

Grossman: No measurements of horizontal permeability planned. Assume that predictive features used for vertical estimates may be applied to horizontal. Millimeters proposed because of observation by people conversant with metric usage that commonly units of length are either millimeters or meters and not centimeters. The unit, millimeters per day, yields numbers in the 1 to 100 range commonly.

IV. Organization of Committee

The committee had four charges for which five subcommittees were established:

Review the ARS hydrologic model USDAHL-74 and investigate its possible application in soil survey.

Application of ARS Hydrologic Model
R. Yeck, chairman
J. Lunin
F. Newhall
D. S. Fanning
R. M. Pasley
C. B. England (participant but not a member)

Develop a model for describing and predicting soil water tables in time and space, including descriptors related to the oxygen pressure of the water.

Development of Water Table Model
R. B. Daniels, chairman
D. S. Fanning
D. F. Slusher
T. J. Holder

Develop criteria for using soil moisture regimes as series differentiae.

Water Regime Criteria for Series
W. W. Fuchs, chairman
C. L. Scrivner
E. A. Naphan
J. Bouma
J. Lunin

Review definitions and criteria related to soil water in Soil Taxonomy and in the draft of the Soil Survey Manual for consistence and for adequacy for classification and interpretation.

Definitions and Criteria in Soil Taxonomy
F. J. Carlisle, chairman
R. J. Arkley
B. Birdwell
Franklin Newhall
L. H. Rivera

Definitions and Criteria in the Soil Survey Manual.
R. B. Grossman, chairman
J. Bouma
M. Stout
B. Birdwell

Each of the four regional conferences had committees that worked on matters pertaining to the charges of this committee. The recommendations of these regional committees were considered.

R. B. Grossman was overall chairman, D. S. Fanning was vice-chairman and K. W. Flach was technical advisor.

V. Subcommittee Reports

A. Application of ARS Hydrologic Model USDAHL-74.

The hydrologic model considered in some detail by this committee was developed by the Hydrograph Laboratory of the USDA (thus the designation USDAHL plus the date of publication). The computer program was developed on an IBM 360-50 computer using level E FORTRAN programming language. The original version, USDAHL-70 (Holtan and Lopez, 1971), has undergone two revisions, the first of which was a review draft (USDAHL-73) and the revision now in press, USDAHL-74. The revisions provide for additional outputs of soil moisture, seepage, and lateral outflow. USDAHL-74 is referred to subsequently as HL-74.

The primary purpose of this model is for watershed engineering. It is quite comprehensive and includes a complete moisture accounting system, the segment explored by this subconnnittee. It is considered a deterministic hydrologic model, a category of models defined as one that studies the hydrologic system as a whole and attempts to model all the various mechanisms and their interactions (Amerman, 1973). The model emphasizes the use of readily obtainable data. Appendix 1 of this report is a more detailed discussion by C. B. England concerning the design, operation, data requirements and applications of the model.

An application of HL-74 in the soil survey would be the prediction of soil moisture content. The moisture content of two horizons of a McLain silt loam near Chickasha, Oklahoma, were predicted over a 15-month period. The results were compared to moisture data collected over the same period by ARS and Oklahoma State University. On the first run, the predicted and measured soil moisture contents were very close with some exceptions which also aligned closely in subsequent runs. The logic of the adjustments and a graphic presentation of the results for a run are given in Appendix 1. This demonstration indicates that the HI-74 model can be used to predict moisture patterns in a soil by horizon, and should be useful to provide answers to more specific soil moisture questions.

Another application is for estimating placement in taxonomic moisture regime classes. Soil taxonomy defines soil moisture regimes in terms of cumulative and continuous days (in some cases during a specified time of the year) during which the moisture control section is moist or dry in some or all parts. The Soil Survey Moisture Regime (SSMR) Model is presently used to calculate moisture contents of the moisture control section (Soil Survey Staff, 1973) and tabulate data for determination of the soil moisture regime. Some aspects of the SSMR model and comparisons to the HL-74 are given in Appendix 2. Our subcommittee found that comparable results of moisture content were obtained by the two models using a soil with very little slope. The HL-74 model considers the entire landscape and accounts for run-on and run-off water as part of its moisture accounting whereas the SSMR model does not. The HL-74 also allows for more vegetative variation than the SSMR model. Other differences are discussed in Appendix 2.

A further application is to predict effects of watershed alteration either cultural or physical. Change of streamflow patterns and water table levels as a result of land treatment measures were predicted using the HL-74 model on the Dividing Creek watershed on Maryland's Eastern Shore (Pasley et. al., 1974). Some soils changed from hydrologic soil group D to group A or B, depending on their position on the landscape as a result of lower water tables. The model has also been used to predict the change of streamflow and overland flow resulting from change of land use on a watershed (personal communication, C. B. England).

Finally, since the HL-74 model does account for lateral flow, it should be possible to predict the average free water surface and its variation throughout the year. The Agricultural Chemical Transport Model (ACTMO), which is an extension of this and other ARS hydrologic models, also has the capacity to predict movement of sediment and water-soluble materials.

Appendix No. 1

Soil Moisture Accounting Component of the USDAHL-74 Model of Watershed Hydrology[1/], [3/]

C. B. England[2/]

A. Introduction

The USDAHL-74 Model of Watershed Hydrology was developed by an interdisciplinary team of scientists as a vehicle for utilizing available soil survey data, agronomic information, published weather data, and concepts of hydraulics in continuous stream flow prediction. Major emphasis has been placed on developing a deterministic mathematical model which accounts for temporal and spatial distribution of hydrologic response to variability of precipitation, soil properties, and land use, The model is structured by considering the watershed as a distributed system of soil-landform unit or zones, parameters for which are estimated from a priori analysis of relief, soil characteristics, and anticipated fluxes in surface and subsurface flow regimes.

This is in sharp contrast with widely used correlation-regression models as well as those which require calibration to lengthy records of rainfall-versus-runoff to estimate parameters for the particular area under consideration.

This report provides a brief summary of the operation of the model, data input requirements, parameter estimation, data output, and an example of its application to a field situation.

B. Operation of the Model

Mathematically, the model is quite simple since it is based on algebraic accounting of water storage and flow throughout the hydrologic cycle on the watershed continuum from ridgetop to the watershed outlet. Dimensions from soil survey are used to compute volumes; rates of all the hydrologic processes are expressed as linear or non-linear functions of the exhaustion of storage volumes in each component, with threshold values established from data freely available in the literature, or easily inferred from other physical characteristics of the area.

1/ Prepared as a report to the National Soil Moisture Committee, Subcommittee on Application of the ARS Model, R. D. Yeck, Chairman.

2/ Soil Scientist and Assistant to the Chief, USDA Hydrograph Laboratory, Plant Physiology Institute, Agricultural Research Center, Northeast Region, ARS, Beltsville, Maryland 20705.

3/ Abbreviated from original.

A few examples from the model illustrate the use of the flow rate: volume-exhaustion computations: (1) the infiltration rate of water into the soil during any time increment is a direct, exponentially decaying function of the air-filled porosity (storage available, Sa) remaining in the upper soil layer at that time. For a given soil, the lower threshold is estimated from the rates associated with the Hydrologic Soil Groups published in the SCS National Engineering Handbook and elsewhere; (2) evapotranspiration rates are computed as an exhaustion function of the water stored in AWC (plant-available water capacity), estimated as the volume of water retained between 15-bar matric suction and 1/3-bar suction (for medium textured soils) or 1/10-bar (for sandy soils); (3) the rate of groundwater recharge, GR, is an inverse function of "free" water remaining at any time in the upper two layers, where "free" water (G) refers to that temporarily stored above field capacity, estimated as the difference between 1/3- or 1/10-bar and total porosity; and (4) the rate of overland flow is computed from the amount of urecioitation excess over infiltration in transitional surface-storage. In the examples discussed above, the rate of each process diminishes as the volume of storage or storage capacity is exhausted.

The model operates on most modern large computers such as the IBM 360 and Univac 1108 requiring only a few seconds of CPU time for each year's data.

C. Data Input Requirements

Data required for operation of the model are as follows:

(1) Precipitation is entered in increments according to the data available. Hourly values published by the U.S. Weather Service in the "Climatological Data" series can be used but detail in the flow rates computed will be limited. Break-point precipitation, i.e., values derived from selected critical points on the time-precipitation graph, is more useful, if available. Amounts of snow must be indicated, since snow does not infiltrate or flow until a subroutine in the model computes melting.

(2) Air temperature and Class "A" evaporation pan data is entered as weekly average of daily maximums and minimums. Fifty-two values for each year's computations must be entered. These are usually derived from climatological data from the nearest weather station of similar elevation.

(3) Land use for the year for each zone must be specified, as well as type and date of each tillage practice applied, such as plowing, grazing, harvest, etc. These data can be changed from year-to-year for each crop or landform unit.

(4) Watershed or plot size, expressed in acres.

D. Parameters to be estimated are of four classes: watershed, soil, crop, and hydraulic parameters. These are shown in Table 1. Although the task of filling in the parameters requested in Table 1 at first glance appears formidable, it is really quite easy and rapid if the appropriate data and maps are at hand. Most of the blanks are self-explanatory; only the least obvious ones are discussed here.

(1) Watershed parameters include: number of acres; number of zones (limit 4 determined by grouping similar soils, land uses, or land capability classes in an elevation sequence); number of routing coefficients (determined from analysis of prior streamflow recession curves, as described in the publication on USDAHL-74 Model); number of crops (limited to nine crops); deep ground water recharge (estimated from average annual precipitation minus runoff minus evapotranspiration); land use or tillage changes from year-to-year must be anticipated.

(2) Soil parameters are averaged for each watershed zone, where G_1 is percent by volume for the upper layer of porosity between saturation and field capacity, AWC_1 is percent porosity between field capacity and wilting point, and ASM_1 is percent water filled porosity on the first day of computation (estimated from precipitation a few days before that date). G_2, AWC_2 and ASM_2 refer to the same values for the second layer. The first layer refers to the zone of major hydrologic activity, i.e., the upper A or Ap horizon of cultivated soils. The lower limit of layer 1 may be plowsole, hard-pan or textural B horizon. Layer 2 encompasses the remainder of the "aerated" soil depth, usually but not necessarily, synonymous with the rooting depth. For soil classification purposes, layer 1 might be specified as the depth which can contain "1" of water, and layer 2 could be the "control section," having a capacity of "2" of water.

(3) Crop parameters are important since they regulate the amount and rate of infiltration and evapotranspiration. The "A" value, ranging from 0.0 to 1.0, reflects vegetative density and thus the degree of surface perforation and connection of the macropore system to the soil surface. (Sample "A" values are given in the model bulletin.) Surface depression storage Vd is difficult to estimate, being large on flat, rough slopes and small on steep, smooth slopes; other factors are contoured rows, bedding, depressions, etc. Crude values for some crops and slopes are given in some hydrology texts. The value ET/EP is the expected ratio of potential evapotranspiration to open pan evaporation. This value ranges from near 0.0 for fallow

ground to larger than 1.0 for tall free-standing crops which provide a "clothes-line" effect, and in locales where advection of warm dry winds occurs. Estimates are plentiful in the agronomic literature. Rooting depth must be estimated as the resultant consequence of growing a crop having a characteristic rooting habit, on the particular soil in question which may or may not have physical or chemical limitations for root growth, and under weather conditions which either favor or limit root penetration. Consultations with plant physiologists and soil physicists are especially helpful in selecting an appropriate root depth. Likewise, the TU and TL values, being the upper and lower cardinal temperatures for growth (and thus water use) of a particular species, must be gleaned from agronomists and plant physiologists. Sample values for a few common crops are presented in the bulletin describing the model.

E. Data Output from the Model. The user requests the form of output depending upon his needs. Options include monthly and annual totals of precipitation, runoff or streamflow, evaporation, transpiration, and groundwater recharge for the entire watershed, or detailed accounting of each component of the hydrologic cycle in each layer of each zone on a daily basis. This includes printing out the amount of water flowing or stored in each surface and subsurface regime, the amount of evaporation and transpiration, the volume of runoff and runon (due to cascading of flows from uphill zones), and the volume of water in soil layers 1 and 2, which is the subject of this report.

F. Application of the Model to a Field Situation, Although the USDAHL-74 Model of Watershed Hydrology was originally developed for continuous streamflow predictions; and recent tests have indicated its usefulness therein by accurately matching observed flows on complex agricultural watersheds up to 100 square miles in size, its comprehensiveness in detailed accounting of storages and flows throughout the watershed makes it adaptable for many other purposes. For example, it has recently been used as the basic hydrologic framework, combined with erosion and chemistry models, to produce ACTMO (Agricultural Chemical Transport Model) soon to be published by the Agricultural Research Service.

One of the key values controlling the rates of processes such as infiltration, evapotranspiration, vertical seepage, and lateral flows is the moisture status of the soil profile at any given time. As mentioned before, the model continuously keeps track of the amount of water-filled porosity in layers 1 and 2 or conversely, the unfilled porosity (storage available, Sa) in both these layers, to control the rates of these processes.

An opportunity to test the soil moisture accounting accuracy of the model was presented by data published by Oklahoma State University and USDA-ARS of soil moisture records near Chickasha, Oklahoma, for the years 1962-1963 (Welch *et al*, OSU Processed Series P-536, 1966). Weekly measurements were made at duplicate sites in McClain loam (fine family of Pachic Argiustolls) on a nearly flat slope (0.5 percent) at eight six-inch depth increments under bermudagrass mowed to a lawn condition... Runoff was stated to be negligible, so all model parameters dealing with runoff and stream-flow were "dummied". Data input was hourly precipitation, average daily temperature, and pan evaporation from "Climatological Data" published by the U.S. Weather Service for that station. Soil and crop parameters in the first run are those in Table 1. Daily output of soil moisture in layers 1 and 2 were requested from the model for comparison with values observed on the same dates at the Chickasha station. Fig. 1 shows excellent agreement between estimated and measured moisture. This was the third of three computer simulations using 1/3-bar water retention determinations based on natural clod measurements and assuming a root depth of 24 inches (less than the complete thickness of the lower depth).

Literature Cited

Amerman, C. R. 1973. Hydrology and soil science. *in* R. R. Bruce, K. W. Flach, and H. M. Taylor (ed.). Field soil water regime. Soil Sci. Soc. Amer. Spec. Pub. No. 5.

Curtis, L. F., J. C. Doorncamp, and K. J. Gregory. 1965. The description of relief in field studies of soils. Jour. of Soil Sci. 16(1):16-30.

Holtan, H. N. and N. C. Lopez. 1971. USDAHL-70 model of watershed hydrology. USDA Tech. Bull. 1435.

______, G. J. Stiltner, W. H. Henson, and N. C. Lopez. 1974. USDAHL-74 revised model of watershed hydrology. Plant Physiology Institute Report No. 4 (in press).

Fasley, R. M., E. G. Riekert, J. Shaffner, and W. Henson. 1974. Daily stream flow for environmental impact analyses. Presented at the 1974 annual meetings of the Amer. Soc. Agri. Eng., Oklahoma State University, Stillwater, Oklahoma, June 23-26.

Soil Survey Staff. 1973. Soil Taxonomy. Interim publication of the USDA Soil Conservation Service, Washington, D. C., October 1973.

Table 1. Sample listing of input parameters for USDAHL-74 Model

WATERSHED PARAMETERS--

ACRES 0.001 NO, OF ZONES 1 NO. OF ROUTING COEFFICIENTS 1
NO. OF CROPS 1 DEEP GROUNDWATER RECHARGE 0.05
DOES LAND USE-CHANGE? No

GENERAL ZONE PARAMETERS--

ZONE	% W/S	LENGTH, Ft.	%SLOPE	FC	DEPTH TOP SOIL, In.	DEPTH SOIL, In.
1	100.0	10.00	0.50	0.05	9.0	33.0

SOIL PARAMETERS--

ZONE	$\%G_1$	$\%AWC_1$	$\%ASM_1$	$\%CRAK_1$	$\%G_2$	$\%AWC_2$	$\%ASM_2$
1	14.0	30.8	15.4	3.0	11.0	29.1	14.6

0

ROUTING PARAMETERS--

CHANNEL ROUTING DELT T = 0.20
CHANNEL COEFFICIENT = 1.00
INITIAL CHANNEL FLO = 0.0

LAND USE PARAMETERS--

CROP	GRASS
A VALUES	1.00
CROP VD	1.00
ET/EP	1.10
ROOT DEPTH	33.0
UPPER TEMP. 'JF	95.0
LOWER TEMP. °F	50.0

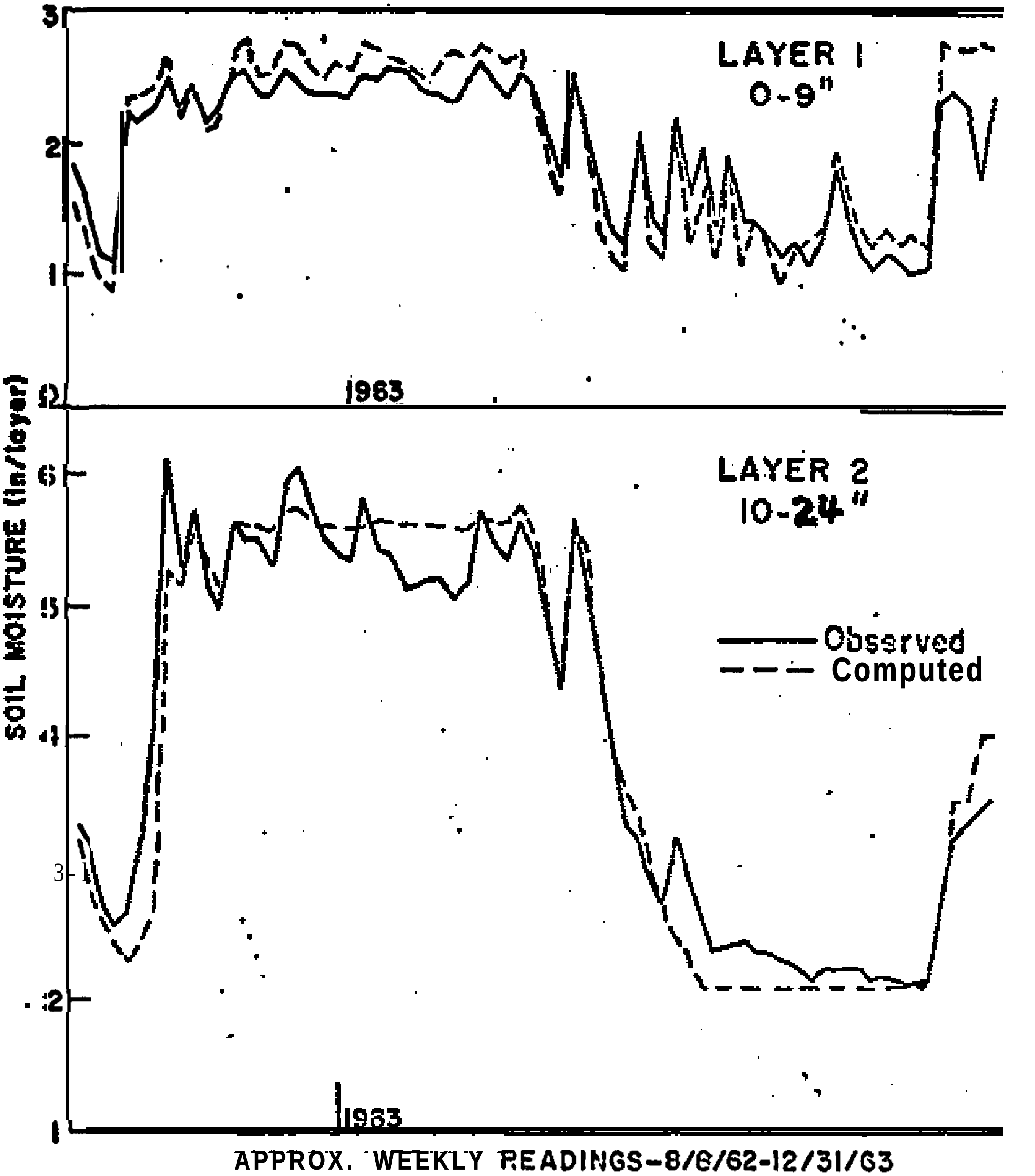


Fig. 1. Soil moisture accounting by model USDAHL-74 for a Pachic Argiustoll in a fine family using data in Table 1, but substituting 24 Inches for soil depth and using 8 lower percent AWC_1 than listed. The listed AWC in Table 1 was based on fragmental samples and is too high.

Appendix No. 2

The Soil Survey Moisture Regime Model (SSMR) and Some Comparisons with I-ID-70

Franklin Newhall

In calculating a soil moisture regime for soil classification, it is the continuous record of changes in moisture content in just one critical layer which determines the soil moisture class. This critical layer, called the moisture control section, lies fairly close to the surface, but, except for a few shallow soils, does not include the actual surface.

Three factors determine changes in moisture in a layer such as the moisture control section: First, the total amount moisture in the soil profile and the distribution of the moisture among the layers; second, the amount of moisture which enters the soil from precipitation; and third, the intensity of evapotranspiration. These three factors were put together into an arithmetic model based on monthly rainfall, and uses simple rules for movement of moisture and the effect of evapotranspiration. The output gives the durations of time, scaled in number of days, that the moisture control section is moist in all Darts ("parts" means "sub-layers"), moist in some parts while dry in other parts, or dry in all parts. This model is the Soil Survey Moisture Regime (SSMR) model.

The SSMR model was used to test some of the moisture criteria used in the publication "Soil Taxonomy". The model has been described in a forthcoming Soil Survey Investigations Report: "Calculation of Soil Moisture Regimes from the Climatic Record," and a program has been written in ANS Cobol IV language to carry out the calculations described in the report.

The limitations of the SSMR model should be kept in mind. Prediction of moisture content is made semi-monthly, in the middle and at the end of each month for eight layers of the soil profile, Including layers 2 and 3, the moisture control section. Durations of Dry, Fart Dry-Fart Moist, and Moist conditions, although expressed as a number of days are actually obtained by linear interpolation between the semi-monthly moisture predictions.

Some of the more striking limitations of the SSMR model show up when it is compared with more complex hydrologic models such as USDAHL-70 or -74.

1. The SSMR model (theoretically) is limited in application to well-drained soils in site positions not subject to excessive runoff or runon or to ponding.

2. The SSMR model does not distinguish between runoff and percolation when it calculates excess water, and hence it does not seem readily applicable to hydrologic problems.

3. The SSMR model assumes that the ease with which moisture can be removed from any layer of soil is inversely proportional to the depth below the surface of that layer.

4. The SSMR model assumes that the ground is completely covered by grass, or that any other cover, including bare ground, will behave the same as grass with respect to the effect of radiation on evapotranspiration.

5. The basic data entering the SSMR model are monthly values which set the precision with which events can be characterized.

B. Development of Water Table Model

The water table and its annual fluctuation in the solum is considered to be an important feature in soil genesis, classification, and interpretations. It is unfortunate that so much emphasis has been placed on water tables because by definition they are a point of zero water tension (Soil Survey Manual). A water table is a plane at the top of a zone of free water saturation, it has no thickness, and alone, it can have no influence on soils. The feature associated with a water table that is important to soil genesis, classification, and interpretation is the underlying zone of free water saturation. The water table measurements along with some morphological features are used to help us interpret the zone of free water saturation. For example, a Pervious soil such as the Rains or Norfolk series will almost always have identical water table elevations in a group of wells open at various depths (Fig. 1A). The morphology of these soils indicates no restricting layer in the solum so the zone of free water saturation is considered to be the zone below the measured water tables (Pig. IA, hachured area). Other soils may have pervious horizons over slowly or very slowly pervious horizons or layers (Fig. 1B). A group of wells in this kind of soil would be installed to test for probable differences in free water saturation. Assuming that water table elevations are found as indicated in Fig. 1B, then the interpretation of the free water saturated zone would be based on a combination of water table elevations and soil morphology. In Fig. 1B only the upper pervious horizons would be interpreted as having free water. An example of a soil with multiple pervious and slowly pervious horizons and interpretation of the free water saturated horizons is given in Fig. 1C.

The seasonal change in the zone of free water saturation for each example given in Fig. 1 is shown in Fig. 2. For Pervious soils, the water table elevations throughout the year can be used to Plot the top of the zone of free water saturation. Soils such as Norfolk, Rains, and Murville are examples that, in general, follow Fig, 2A. The base of the pervious horizon most commonly will be used to define the base of the zone of free water saturation in soils that have restricting or slowly pervious horizons. The seasonal change in the saturated zone is much different from a pervious soil with similar seasonal water table elevations (Fig. 2B). The pervious soil almost always has a zone of saturation at some depth, but the soil with slowly pervious horizons may have only a relatively thin zone of free water in the upper part of the solum that is highly discontinuous during the year. The Calhoun and Grenada soils of Louisiana fit the concept of Fig. 2B. Fig. 2C shows the seasonal changes in free water saturation in a soil that has multiple slowly pervious horizons or layers. Intergrades between the seasonal zones of free water saturation shown in Fig. 2A and B are found in some soils with plinthite such as Dothan, Fuquay, and Varina. Fig. 2D illustrates how free water may be perched by plinthite or other horizons above a deeper zone of free water, and how these two zones may merge and separate over time.

Understanding where the zones of free water saturation are and their seasonal changes are extremely important in soil interpretation, especially in soils on sloping landscapes with pervious over less pervious horizons (Fig. 1B). On nearly flat landscapes there probably is little horizontal transfer of water because the hydraulic gradients are almost nil. But, on sloping landscapes free water commonly moves downslope (the through flow of hydrologists) above the less pervious horizons, eventually coming to the surface as stream flow or seepage areas on the lower slopes (see Nutter, 1973, SSSA Spec. Pub. No. 5, p. 181). Observations indicate that lateral transfer of free water downslope is very common in the arenic soils of the southeast. The time of free water saturation may be very short, a few hours, on the upper parts of the slopes. Attempts to show the zones of saturation graphically (Fig. 2) would require a large time scale. Yet, for some interpretations, especially ion transfers, these very short term periods of free water saturation are important and it is during these periods when most of the soluble material is transported from one point in the landscape to another.

Interpretations of zones of free water saturation can be no better than the data collected. It is extremely important in soils with slowly to very slowly pervious horizons to have cased wells properly installed. The methods of installing well casings detailed in the "Handbook of Soil Survey Investigation Field Procedures" (p. 15-l-3) have been satisfactory at more than 100 sites. The short and long term perching of water above less pervious horizons such as fragipans, plinthite, dense clay layers, etc. is evidence of satisfactory performance of the wells and apparently water is not flowing down the side of the casing. We believe that tamping soil around the casing is the major reason for success. But, if the casing is pushed into a hole made by a smaller auger or probe, the upper part of the hole becomes enlarged and water from overlying horizons can flow down the side of the casing. Experience in Louisiana suggests that water moving along the outside of the casing is common in many wells installed without careful tamping of the soil. Casing should be installed with the same care used in most laboratory procedures because the validity of the data depends upon the installation.

Well casings opening into slowly or very slowly pervious horizons probably should be pumped dry after reading water levels. Many of these horizons will have some free water for short periods each year, but water will move out of the cased well into the surrounding materials very slowly. Removing the water will help prevent recording false data and give a check on the effectiveness of the casing installation when free water is in the overlying but not the underlying horizons. Considerable judgment is required, but most wells in pervious materials do not need to be pumped after reading unless water samples are required.

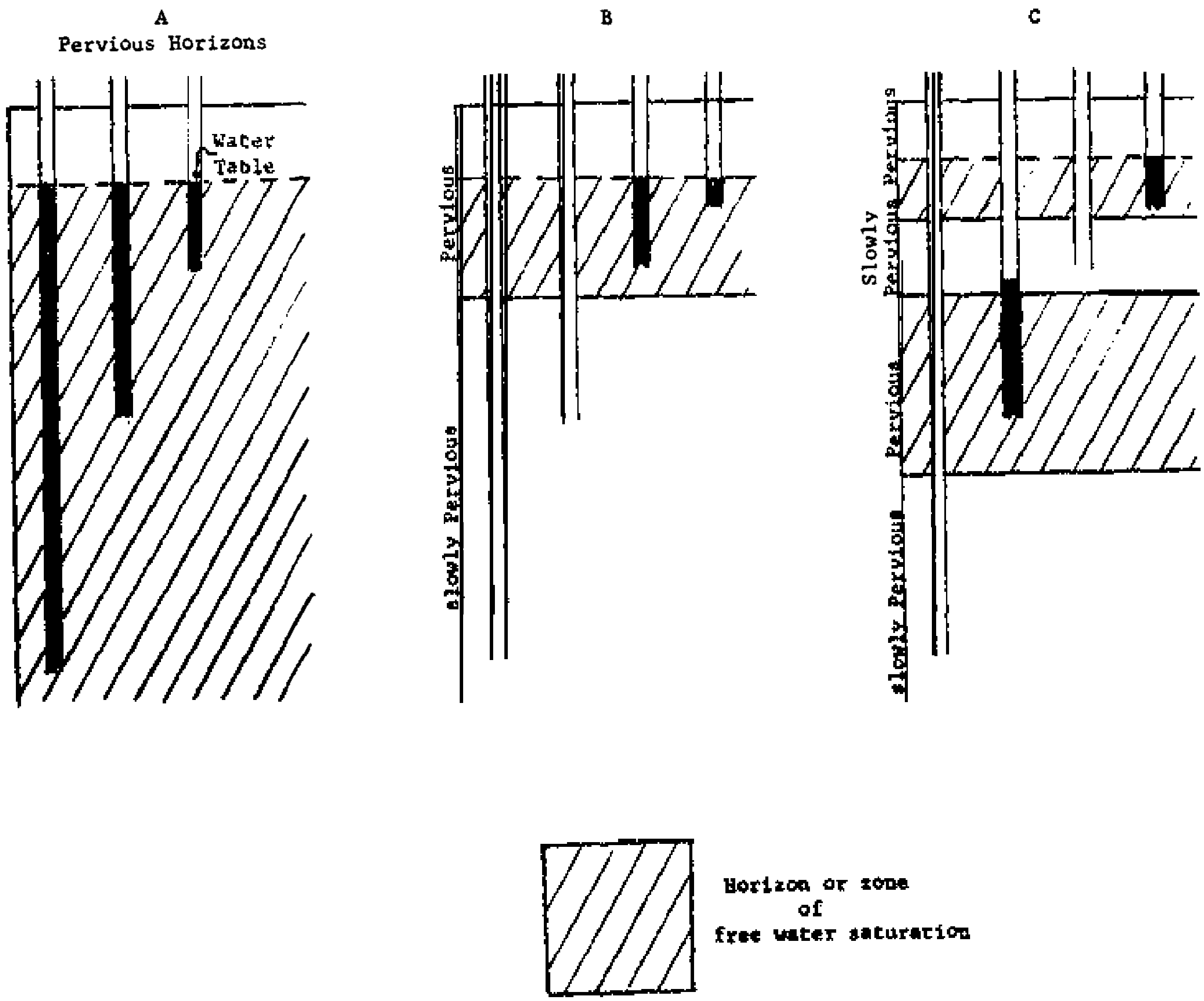
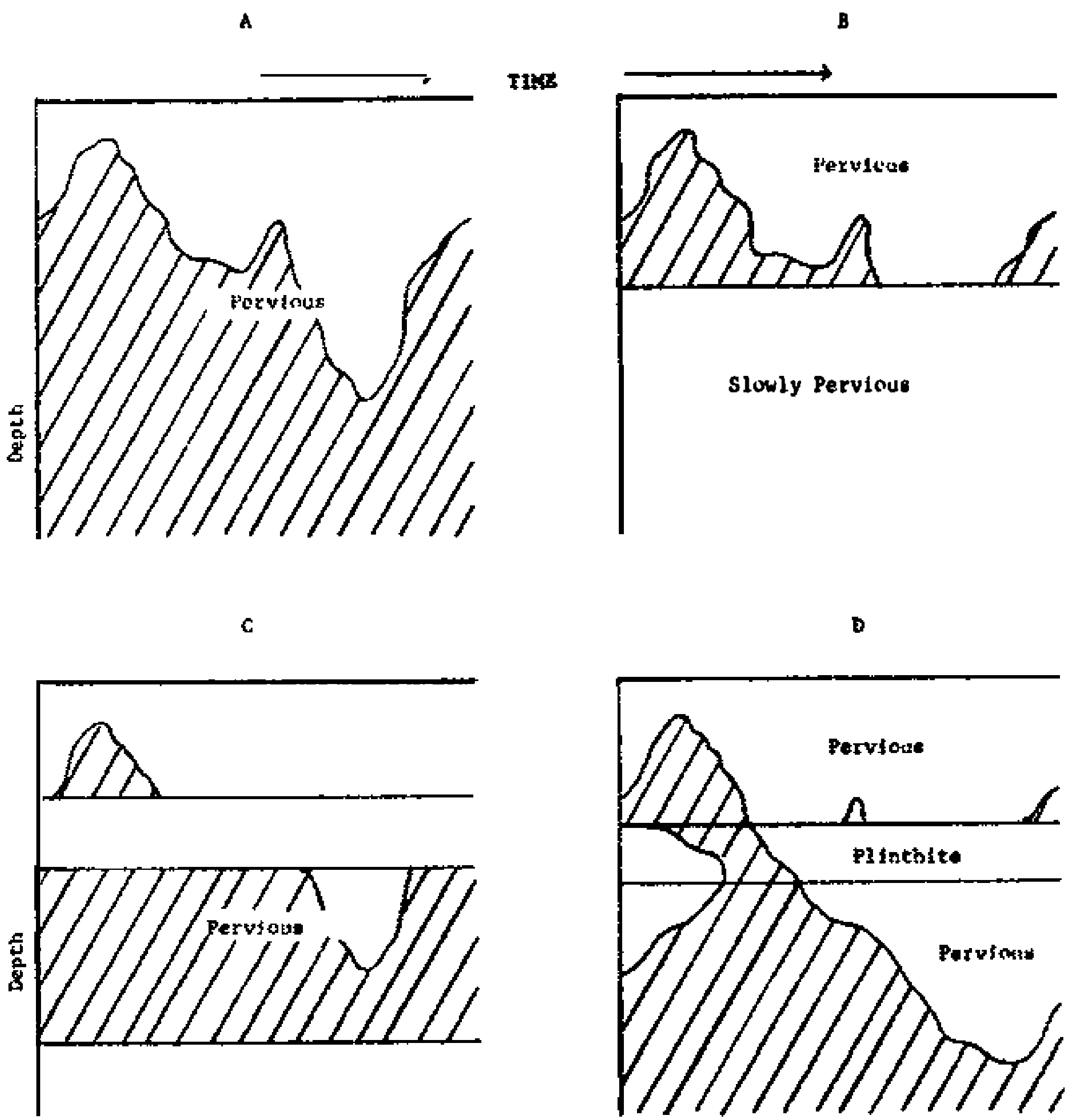

A
Pervious Horizons
Water
Table
B
Pervious
slowly Pervious
C
Slowly
Pervious
Pervious
Pervious
slowly Pervious
Horizon or zone
of
free water saturation

Figure 1



A
B
TIME
Pervious
Pervious
Slowly Pervious
Depth
C
D
Pervious
Pervious
Plinthite
Pervious
Depth

Figure 2

C. Water Regime Criteria for Series

Series are normally separated within families because of different response. The differentia has commonly been tied to morphological features. Many of the series separated by morphology owe their different response to different moisture regimes. Available moisture is affected by the sand-silt ratio, percent coarse fragments, structure, porosity, and many other features used to separate series. The separation of red, strong brown, and yellow soils relates in part to drainage characteristics.

The need for soil moisture criteria is more evident where we lack morphological clues. We recognize different response within a family, but lack the accepted differentia to place into separate series. Some examples of possible series criteria which are not presently tied to morphology are:

1. Warm season precipitation, as it relates to woodland site index.

2. Length of the moisture deficit period in Ultisols, as it relates to crop yields, such as corn, which is highly sensitive to moisture stress at certain stages of development.

3. Soil shape in non-aquic great groups, as it relates to moisture movement and retention.

4. Consecutive days moist in ustic great groups, such as Ustalfs and Ustolls, where free lime or absence of free lime does not indicate the more moist (udic) or less moist (typic) subgroups.

5. Depth to and duration of the water table, as well as the nature of the water table (aerobic vs. anaerobic).

The question relating to use of non-morphological features touches on a basic problem. The ideal has been to be able to predict soil behavior using a morphometric on-site analysis. But many processes do not leave specific "marks" on the profile and measurements are therefore needed to directly characterize the processes themselves. This presents a handicap to the soil surveyor: rather than a one-time observation, a cumbersome series of measurements is needed covering many seasons. Fbr example, water-table measurements and moisture tension measurements take a lot of time and have to be made for several years to be meaningful. We are interested in the water "climate " not the "weather". There is a potential danger that elaborate'schemes could be proposed for classification Of field soil water regimes, without establishment of a good physical field monitoring program at the same time. The first activity loses its significance without the latter. We have this problem currently with regard to estimating soil permeability. Estimates for permeabilities are given in soil survey reports for major horizons in soil series and we would feel more comfortable if more physical measurements were available to check them. We should not use physical data, obtained by long-term monitoring, in the same easy way in classification as we have used "instant" morphological data (mottles, diagnostic horizons, etc.).

Series criteria historically have not had hard and fast break points as has taxonomy. Soil series have been differentiated, where needed, based upon response using morphological features. Criteria based on non-morphological features of soil moisture regimes are needed until we detect morphological clues. We need careful study to assure that we have focused on the correct non-morphological clues. For non-morphological features especially, we need judgment and broad guidelines rather than specific break points.

To develop meaningful criteria for series based on soil moisture regimes, we first need to develop definitions and terms we can apply uniformly. It is important to avoid complicated schemes for classification and naming of soil moisture regimes. The proposals by the SRTWPC seem appropriate, especially when they are expanded to characterize the soils dryer than aquic subgroups.

Soil moisture regimes for soil series should be defined as broad categories listing most probable water table depth and moisture content in the rooting zone as a function of time during the year. Each regime should be characterized with a specific name.

Hydraulic properties of soil series as related to unsaturated flow and moisture retention curves are of great importance in predicting response. Specific names and definitions should be selected for these. Detailed field monitoring of key soil series may be needed to provide data on which to base classification schemes for soil moisture regimes.

D. Definitions and Criteria in Soil Taxonomy

The charge for the subcommittee was to review the definitions and criteria related to soil water in Soil Taxonomy for adequacy for classification and interpretation. The scope of the review by the subcommittee was limited to those criteria and definitions that are stated directly in terms of soil water.

Terminology

The 1974 Western Regional Committee on Water Relations in Soils reviewed the definitions and criteria related to soil water in Soil Taxonomy (preliminary abridged text, October 1973) and found some inconsistencies in terminology relative to water movement.

Classes of permeability are used in some places and classes of hydraulic conductivity in others, The moisture state to which the statements applied is specified in some instances but is omitted in others where it would be relevant. They thought such inconsistencies might lead to misunderstanding of the intent of the statements and to errors in interpretations. The committee recommended that terminology pertaining to soil water, particularly to water movement, that is used in Soil Taxonomy should be reconciled in future revisions of that document with the terminology that is finally adopted for the revised Soil Survey Manual.

Soil Moisture Criteria

With respect to criteria that are used to set apart classes and that are stated directly in terms of soil water, it seems helpful to think in terms of three groups of soil moisture criteria. One group is the set of five major classes of soil moisture regimes that are defined on pages 47 through 51 of the abridged text dated October 1973. Of these, the aridic (torric), udic, ustic, and xeric classes are defined quantitatively; only the aquic class has a qualitative definition. One or more of these classes are used as differentiae in the order, suborder, great group, and subgroup categories.

A second group consists of a few other quantitatively defined criteria that are used to set apart subgroups in some great groups of Alfisols, Aridisols, Entisols and Mollisols.

The third group consists of the qualitatively stated soil moisture criteria that are used to distinguish between subgroups of some great groups of Aridisols and Entisols. Examples are the distinction between Ustollic Haplargids and Xerollic Haplargids (page 122) and the distinction between Ustic Torrifluvents and Xeric Torrifluvents (page 148).

With one exception, testing of the soil classification system through its use in this country has not led to serious questions regarding the adequacy of the soil moisture criteria that are used to set apart classes in the subgroup and higher categories. This probably follows in large part from the scarcity of long-time records of soil moisture variations that are needed to test the criteria.

The exception concerns the adequacy of the present definition of the aquic moisture regime.

Aquic Moisture Regime

The 1974 Southern Regional Committee on Soil Wetness recommended a modified definition of the aquic moisture regime. They also recommended that the aquic moisture regime be subdivided into three parts on the basis of the part of the soil that is saturated. A brief summary of the reasons for their recommendations follows. A more complete statement is in the report of the Southern Regional Committee.1/

The definition of the aquic moisture regime in Soil Taxonomy (page 49) states, "The aquic moisture regime implies a reducing regime that is virtually free of dissolved oxygen because the soil is saturated by ground water or by water of the capillary fringe". A major problem in the application of the definition is measuring how high the capillary fringe may rise in a given soil. The water table can be measured easily with simple tools. The capillary fringe may extend from perhaps 10 cm to a meter or more above the water table. The thickness of the capillary fringe depends on whether the soil is wetting or drying and it cannot be measured easily in the field. An additional disadvantage of the definition is that inclusion of the capillary fringe as part of the saturated zone is at variance with accepted definitions of saturated zones used by hydrologists and ground water geologists.

Recent studies in Louisiana indicate that many soils that are classified in aquic suborders, such as those of the Crowley, Beaumont, and Sharkey series, do not have high water tables even though their morphology, position on the landscape, and the rainfall patterns are consistent with that classification. These soils can have water standing on them or go through prolonged periods (1 to 2 months) of high rainfall and low evapotranspiration without exhibiting saturation by free water below the surface horizon. The A or Ap horizons may be wet but water will not stand in a bore hole if the upper horizons are sealed off, and the B horizon will absorb added water.

In other soils, represented by the Calhoun and Foley series in Louisiana, the zone of free water saturation is confined to the upper 1 or 1 1/4 meters and the underlying layers are not saturated. This condition is believed to be fairly common in sloping areas of the Coastal Plains and Mountains although the soils involved probably have udic moisture regimes rather than aquic regimes. The aquic regime as now defined implies that a saturated zone of unknown thickness underlies the water table and that the water table is relatively free to fluctuate through this zone.

In a third group of soils, represented by the Mhoon series in Louisiana, the water table evidently is free to fluctuate through several meters and free water can be present throughout the soil.

Judging from their morphology, the soils in the three groups mentioned above have reducing regimes and are properly classified in

1/ Proceedings of Southern Regional Technical Work Planning Conference of the Cooperative Soil Survey. Mobile, Alabama, March 11-15, 1974 aquic suborders. Yet, the difference in the zones of saturation by free water in the three groups should be of consequence to engineering and other uses of the soils.

Irrigated Soils

The expression "unless the soil is irrigated" appears frequently in the definitions of classes in Soil Taxonomy. A question has been raised on the procedure to follow if a soil is irrigated and no unirrigated area is available on the same soil nearby from which the moisture regime can be determined. In this situation we know of no alternative to estimating the moisture regime from the climatic data, as described in Soil Taxonomy (page 48). In most instances, such estimates will be as valid as estimates for unirrigated soils where direct, quantitative observations of the soil moisture regime are lacking.

E. Definitions and Criteria in Soil Survey Manual

The subcommittee considered these matters:

Subject	Pages in Chapter 4 of 4th Draft
Perviousness classes.	50-55
Expansion of approach used in classes of patterns of soil-water states to describe depth to, thickness and duration of zones of free water.	58-65
Available water versus water-retention difference.	66-69
Criteria for soil-water states.	44-48

The northeast and western regional committees worked on water description in the new Manual and their comments have both influenced this report and been forwarded to Dr. McClelland, who is in charge of completing the Manual, along with a number of suggestions of a detailed nature by Johannes Bouma. Ideas herein were discussed with the staff of the SCU, MTSC; their assistance is very much appreciated. The suggestions on the description of zones of free water are largely based on observations and recommendations by R. B. Daniels, which appear in part in the subcommittee report herein on water table models and in the report of the Southern Regional Committee on Soil Wetness.

Perviousness: The advantages of perviousness as a term is that it provides a word to describe the relative rate of water movement that is not tied to a specific kind of measurement and state of the soil--that is whether saturated or unsaturated. The latter is particularly significant because the water movement of interest to plant growth occurs in the main under conditions of unsaturation. 'Ike term could be used in parts of publications of the soil survey written for the layman. It avoids the problem with permeability that the term has both a qualitative meaning (quality or state of being permeable, Webster's), and as used in the interpretations program of the cooperative soil survey is synonymous with vertical saturated hydraulic conductivity. There is one very important, and to the subcommittee paramount, advantage to the term permeability: Estimates of it for the principal zones of the soil form part of the documentation of series and are included in the engineering section of standard soil surveys. Thus, its use reduces the complexity of terminology and provides a closer link between inputting and outputting of pedological descriptions.

The need for lowering the upper limit of the lowest class of permeability is supported by Fig. 1, which contrasts the classes used by soil engineers and the present classes used in the cooperative soil survey. (Units of feet per day are converted to inches/hour by dividing by 2.) The limit of 0.0006 in/hr corresponds closely to the upper limit for suitability for water retention of 0.001 ft/day in SCS construction specifications. The class names proposed involve dropping "very rapid" and replacing it with "very high". The other current class names are retained.

The limit of 0.0006 in/hr is not measurable in the field with the double tube method for saturated hydraulic conductivity above the water table (personal communication, J. Bouma). Limited experience by the writer suggests that values down to 0.006 in/hr may be measured practically. According to A. Rogowski (personal communication), the lower practical limit of the air-entry permeameter is about 0.06 in/hr, the present upper limit of the lowest class. Rogowski does indicate that the air entry permeameter may be modified to measure values of 0.0006 in/hr. The SCS soil mechanics laboratories measure values down to 0.0006 in/hr using the core method. The question and its resolution is not for the soil survey alone to consider, since the matter pertains to the soil mechanics program in the SCS as well.

The committee considered and rejected the general application of the term permeability to horizontal water movement. Specification of the maximum horizontal conductivity would be useful in evaluating suitability of soils with variable layers within the control sections for septic tank performance, agricultural drainage, rapid long-range movement of pollutants, and the like. It was felt,. however, that always to specify both the vertical and the horizontal permeability would be too cumbersome. Permeability estimates by horizon or zone on the series interpretations sheets or in tables in soil survey publications usually may be used to determine the maximum horizontal rate on the assumption that the vertical and horizontal permeabilities are similar. If that assumption is clearly misleading, the vertical permeability estimate should be footnoted. Horizons that are highly stratified or clay-banded sands are examples of where vertical and horizontal permeability are likely to differ by over tenfold.

Free Water: The patterns of soil-water states provide a set of terms to express the taxonomic moisture regimes in common English words suitable for interpretive statements. For many soils, however, taxonomic placement is not a useful predictor of depth and continuity of free water. Hence, for these soils, the present set of pattern terms is inadequate as a basis for several kinds of nonagricultural interpretations. For example, suitability for landfill sites is influenced by depth to free water during the winter months, when the presence or absence of free water has little or no influence on morphology and hence on taxonomic placement in soils of mesic and frigid areas. It is primarily for this reason that the expansion of the patterns to describe the free water in soils more precisely is recommended.

These sets of classes could be used to form statements, such as follows:

Very shallow; restricted; very thin; June through September
Deep; continuous; April through May; extremely deep remainder of year
Shallow; restricted; multiple; thick; January through April

Such statements could be added to the term descriptive of the taxonomic placement, as for example "usually moist," for Udolls to form a statement. Usually moist with deep, continuous free water, April through Nay, and extremely deep free water the remainder of the year.

Free water is used in place of water table because the latter term leads to confusion among disciplines and for the reasons given in the subcommittee report herein on water table models.

Available Water Capacity Versus Water Retention Difference: The recommendation for greater emphasis on water retention difference in the Manual is predicated on a change in the series interpretative sheets to replace available water capacity estimates by water retention estimates. Some arguments in support of this change are that

a) AWC estimates cannot be readily checked by measurement; WRD can. Consequently, WRD is readily subject to adjustment, whereas AWC to the extent that it differs from WRD is not easily checked.

b) WRD fits well into ADP application of soil survey reports. The national data bank would contain WRD. A specific report would contain WRD plus a discussion of the estimation of AWC for the soil uses in question.

c) WRD estimates may be used for other purposes such as calculation of field capacity and application of relationships between unsaturated hydraulic conductivity and volumetric water content. AWC estimates, if adjusted from WRD, cannot be so used.

d) WRD lend themselves to the preparation of irrigation guides in which the proportion of the WRD used differs depending on crop, texture and capacity of the crop roots to exploit the horizons.

The guidelines for the laboratory tension rest on the assumption that lower tension should be employed for coarser soil materials, and that the tension used for sandy loams and coarser should be lower if the materials have moderate or higher permeability (saturated hydraulic conductivity) and are located a short distance above a zone with either markedly lower permeability, example: Patricia series; fine sand over sandy clay loam, or a very coarse particle-size distribution, example: Estherville series; sandy loam and loamy sand over gravelly coarse sand with 2-5 percent passing 200 mesh. The general basis for the proposal, but not the specific guidelines, is discussed in the paper by D. E. Miller, "Water Retention and Flow in Layered Soil Profiles," in SSSA Special Pub. No. 5. The distance of 30 cm is probably conservative. In practice it would be inclusive of the horizon with over half of its thickness within 30 cm of the contact, and perhaps the definition should be so written. Use of saturated hydraulic conductivity in these guidelines is not a good solution, since the relevant property is unsaturated hydraulic conductivity at low tension, but it would seem the more practicable alternative at the present time. The stipulation for oxidic families originates from experience with clayey Oxisols of Puerto Rico, which had appreciably higher field water contents than the l/3-bar retention.

<u>Criteria for Soil-Water States</u>: Marlin Cline, who largely wrote the current draft of the Manual, felt that improvement in the criteria for field evaluation of the soil-water state would be a useful committee function.

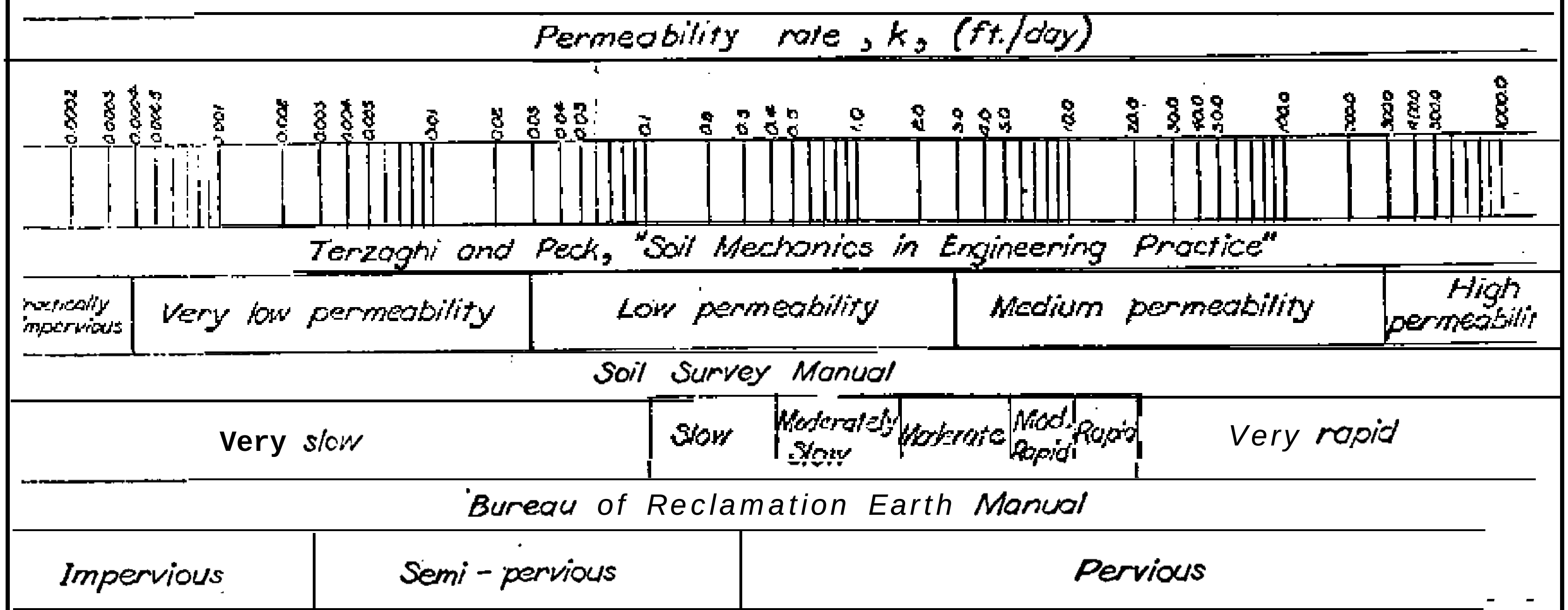
Soil-water state is defined by tension; 0.1- and 15-bar are the criteria for separation of three classes--dry, moist and wet. An optional subdivision of moist into very moist and slightly moist may be made, using as a basis halfway between 15-bar and 0.l-bar water contents.

One approach is to use a tensiometer to establish whether wet or moist. Another approach is to measure the water content directly with a calcium carbide moisture meter. This measured water content is compared to estimates of 15-bar retention obtained by multiplying the clay percentage by an assumed factor, which for many soil materials may be taken as 0.4.

A water tension criterion rather than water content for the separation of very moist from slightly moist is desirable to avoid large energetic variability in the water state described by the terms. A criterion of 0.8-bar is attractive because it's about the highest tension measurable on a practicable basis with commercial vacuum tensiometers. A tension near l-bar as a criterion would stimulate the development of capability by soil scientists to evaluate water state near where most plants under conditions of high water need begin to show evidence of water deficit.

Figure 1

COMPARISON OF CLASSIFICATION OF SOILS ACCORDING TO THEIR COEFFICIENTS OF PERMEABILITY



Prepared by L. P. Dunnigen, SML, MTSC

1975 NATIONAL SOIL SURVEY CONFERENCE

TECHNIQUES FOR MEASURING SOURCE AND YIELD OF SEDIMENT

COMMITTEE 5

The charge for this committee was as follows:

Assess the various techniques that can be used to measure the yield of sediments from sources such as:

1. All or segments of watersheds in relation to land use and topography.

2. Construction areas.

3. Mining areas.

4. Critical eroding areas or point sources from areas of active erosion.

Summary:

Committee 4 of the Western Regional Technical Work-Planning Conference of the Cooperative Soil Survey had the same charge. The discussion and recommendations of this committee have been very helpful to the sub-committees in responding to the charge. The members of Committee 4 are commended for their fine work.

Subcommittee A addressed point 1 of the charge and Subcommittee B addressed points 2, 3 and 4. Each of the subcommittees prepared reports on their portion of the charge and made recommendations for consideration by the national conference. These recommendations were reviewed by the four discussion groups during the conference, revised as needed, and combined into one list.

The list of recommendations is followed by the discussion from the floor of the conference and by the subcommittee reports.

RECOMMENDATIONS:

1. The National Cooperative Soil Survey (NCSS) should vigorously encourage cooperative involvement of federal, state, and regional agencies and institutions in refinement of individual parameters

of the Universal Soil Loss Equation. The NCSS should take an active pert in the selection of appropriate sites in order to extend and project the data to other applicable areas. Research is needed on "K" values for soils that occur on long slopes, on slopes less than 2 percent, and for soils that occur on slopes steeper than 20 percent. NCSS should make these research needs known to ARS, CSRS, and the experiment stations.

2. The soil loss prediction method currently used by the U. S. Forest Service in certain western states should be evaluated in selected western locations by SCS in cooperation with ARS and the experiment stations.

3. Wider distribution of Geology Technical Release No. 51 dated September 1972, "Procedure for Computing Sheet and Rill Erosion on Project Areas" should be obtained so that experiment stations, ARS, SCS and others can fully test the procedures.

4. The NCSS should interface with ARS and EPA on the handbook contract currently underway on non-point sources of pollution. Dr. McCracken, ARS, is USDA chairman for this project.

5. The NCSS should actively support the development of regional models defining the transportation characteristics of sediment. These models include erosion, deposition, and size distribution of sediments. It is desirable that these models reflect land under different cover and cultural practices that will interface with hydrologic and chemical transport models. The NCSS should work closely with researchers who are developing these models.

6. The National Cooperative Soil Survey establish a Task Force (Multidiscipline) on Critical Eroding Areas to

   a. assemble and evaluate current research

   b. interface with existing interagency committees and groups such as SEAM

   c. explore ways soil survey can assist ongoing activities in studies of erosion and sediment yield

   d. identify soils, regions, kinds of disturbed areas for which data are needed

   e. communicate data needs to appropriate research institutions,

7. That NCSS actively encourage the continuation and increase of research grants, especially from the Environmental Protection Agency and the National Science Foundation, to appropriate research institutions for studies of soil erosion and sediment yield. Special emphasis is needed in areas of energy-related surface mining.

8. That the amount of accumulated sediment continue to be measured in the selected "566 Watersheds" and that the group making these studies be urged to continue evaluation in relation to predicted soil loss based on the Universal Soil Loss Equation. That NCSS contribute any needed soil survey data.

9. That the National Cooperative Soil Survey follow the research on the usefulness of the portable rainfall simulator used by Gordon Huntington of the University of California closely and make any needed soils input to assist in the ongoing research.

10. That the pin-hole method, used at SCS' Soil Mechanics Laboratory at Lincoln to investigate dispersion, be evaluated to determine its potential for use as an indicator of erodibility. Soil Survey Investigations Unit at Lincoln is the logical choice to do these studies.

11. That the committee be continued and that the committee report as amended be accepted by the conference.

Discussion from the floor of the conference:

Bartelli - What parameters of the Universal Soil Loss Equation are we concerned with? Has any portion of the equation surfaced as weak?

Hidlebaugh - The committee discussed apparent weaknesses of "K" values of some soils and C and P factors.

Johnson - Need recommendation for action that is specific.

Carter - Should include the "R" factor.

Miller - Make recommendation in terms of small-scale studies that can be conducted.

Fenton - The Universal Soil Loss Equation was intended to be used with slopes less than 20 percent. Need research on soils with slopes greater than 20 percent.

Flach - We also need research on a rill factor.

Bartelli - Recent research work has not looked at slope length. We also need to identify the soils at the original research sites.

Ralston - We have concern about extending use of the equation to long slopes. ARS is interested in doing this research, but they need support.

Ralston - SCS has made a request to ARS to conduct research on "K" values for soils with slopes less than 2 percent and greater than 20 percent.

Suggested by several participants that the Washington staff take the initiative in expressing research needs to ARS.

Bartelli - Need to develop guidelines to improve "K" values for soils with slopes less than 2 percent. Go back to Dr. Wischmeier and ask him to look at "R" values of selected areas again.

Recommend that we prepare a list of recommended research items for presentation to ARS.

Grossman - The last recommendation is already underway.

Bartelli - NCSS is not an administrative unit. Who do we talk to in order to get something done? Can direct work to regional work planning conferences.

Grossman - The senior soil survey staff might make sure that recommendations are implemented.

Bartelli - This could be recommended from the floor.

Johnson - Not necessary. NCSS is a concept, not an incorporated body. May want to focus recommending to any one group. We in h'ashington can direct recommendations to areas, states, or others. We have to get recommendations pointed to someone.

Coover - Could the conference make specific recommendations to someone or agency?

Bartelli - Yes, we could.

Recommendations for research should be compiled into one list as defined by NCSS.

Flach - ARS needs specific points to work on and reinforcement of ongoing research.

To what extent should we direct research needs to CSRS?

Miller - Regional grants are available ($3.5 million per year). These funds are the only ones available which we might influence as to type of research. Soil loss studies are not a part of this research this year. EPA is now getting most of the research money. Still need requests to keep research in USDA.

It was moved and seconded that the conference accept the Committee 5 report. The motion carried.

Committee 5 Chairmen:

A. R. Hidlebaugh, Chairman

D. E. Pettry, Chairman, Subcommittee A

D. E. McCormack, Chairman, Subcommittee B

SUBCOMMITTEE A

1975 NATIONAL SOIL SURVEY CONFERENCE COMMITTEE ON TECHNIQUES FOR MEASURING SOURCE AND YIELD OF SEDIMENT: ALL OR SEGMENTS OF WATERSHEDS IN RELATION TO LAND USE AND TOPOGRAPHY

Subcommittee Charge: Assess the various techniques that can be used to measure the yield of sediments from sources such as all or segments of watershed in relation to land use and topography.

Due to the complex general nature of the charge and the inferred relationships with sediment sources, the committee assessed the useage of the Universal Soil Loss Equation relative to watershed sedimentation and techniques for measuring sedimentation. Previous work by a similar committee of the Western Regional Work Planning Conference was utilized in this report.

Background

The natural processes of sedimentation may be simplified into three basic elements: erosion, transportation, and deposition of materials by the action of rainfall, runoff, and gravity. The dynamic equilibrium of sedimentation may be severely altered by cultural activities. Although sediment derived from natural and agricultural sources has been a concern in the past, land use changes and massive land alterations have created additional concern.

Population migration from rural to urban areas has resulted in major changes in land use. According to recent census data, about 60 percent of the U. S. population resided in rural areas in 1900, and the proportion declined to 26 percent by 1970. These land use changes and intensified usage of watersheds have influenced surface runoff, erosion, and sedimentation. Studies indicate that sediment from relatively small urban areas can exceed by 20 to 40,000 times the amount from rural areas (Wolman and Schick, 1967; Guy and Ferguson, 1962). Espey et al. (1966) reported the volume of runoff per unit areas from urban watersheds increased about 200 percent relative to rural. watersheds. Small changes to natural watershed cover drastically increases surface runoff (Anderson, 1963). Guy and Ferguson (1962) reported a deposition of 19 acre-ft. or 25,000 tons of sediment were deposited in Lake Barcroft near Washington, D.C. for each square mile of completed residential construction in the watershed. Based on stream sediment data, the estimated annual worldwide yield of sediment to the oceans is about 20 billion tons or nearly 15.3 million acre-ft. (Holeman, 1968).

It seems evident that techniques for measuring sources and yield of sediment are dependent on the understanding of the erosion, transportation, and deposition relationships. Not only are the field methods and equipment used to collect data important, but also a knowledge of the sediment and its distribution.

A. Assessment of the Universal Soil Loss Equation Relative to Watershed Sedimentation.

Since about 1961 the Universal Soil Loss Equation has been useful for predicting field soil loss. The initial primary purpose of the soil loss prediction procedure was to provide specific and reliable guides to help select proper conservation measures for agricultural lands (Wischmeier and Smith, 1965). In recent years the equation has undergone various modifications in order to utilize it as a soil loss prediction method for uses other than agriculture. The basic equation is represented by:

$$A = RKLSCP$$

where A = average soil loss in tons/acre; R = rainfall factor; K = soil erodibility factor; LS = slope length and steepness factor; C = cropping and management factor; P = supporting conservation practice factor.

Factor R was refined (Wischmeier and Smith, 1958) as:

$$R = EI/100$$

where E = storm energy in foot tons/acre-inch and I = maximum 30 minute intensity in inches/hour.

Soil erodibility factor K describes the inherent soil erodibility expressed as tons/acre/unit of rainfall-erosion index (R). Continuous fallow tillage on a 9%, 73 foot long slope is the reference condition.

Discussion

Inquiries on the usage of the Universal Soil Loss Equation relative to sediment sources revealed both optimistic and pessimistic usage as well as alternate procedures. Unfortunately, it appears that some may have incorrectly related erosion predictions established via the equation with actual sediment yield. It is rather evident that erosion losses of a specific area may have little, if any, relationship to sediment yields in a stream or from a watershed.

Actual data comparisons of predicted soil losses versus measured erosion appear rather limited on a continental basis. Although close data agreement has been reported at individual locations, there appear to be discrepancies over broad areas in attempts to match predicted soil loss with measured erosion and sediments on a storm to storm basis, or annual basis. Numerous modifications and refinements of individual parameters of the equation are underway. Additional components involving complex slope factors and energy parameters are evolving.

A synopsis of pertinent subcommittee comments and inputs from the Western Regional Committee are presented as follows:

a. Rainfall erosion index is currently a function of storm energy and rainfall intensity. In many western states and other areas, erosion is more related to the form and fate of winter precipitation than to intense summer storms. Winter antecedent soil moisture and permeability (frozen soil), and rain-on-snow events are highly correlated to soil erosion losses and to channel scouring.

b. Cropping, management, and conservation practices nomographs evolved primarily in agricultural row crop areas of the east and midwest. These data need to be expanded for a wide variety of land uses and vegetative cover types on a continental basis. Broad class categories such as "rangeland", "flatwoods", or "Douglas-fir forest land" are not satisfactory categories. Cover types should be related to overall ground protection and to the radiation energy budget; a function of overstory, understory, and litter. Cover factors should be a variable, dynamic function dependent upon the sequence of climatic events; i.e., a full soil cover during periods of little potential runoff, versus minimal soil cover during periods of potential overland flow.

c. The validity of EI indices values in excess of 350 have not been fully substantiated and create considerable doubt. Oceanic-orogenic climatic regions such as Puerto Rico, the Virgin Islands, Hawaii, and perhaps Alaska are affected. The term "Universal" may be inappropriate and perhaps misleading.

d. Assignment of a valid rainfall factor (R) to orographic areas such as the Palouse and Nea Perce Prairies of Washington, Idaho, and Oregon is a questionable, difficult problem.

e. Considerable skepticism exists relative to usage of estimated K values on a state-wide basis without adequate field data.

f. Soil erodibility nomographs for farmland and construction sites do not appear to be applicable to many tropical soils. Questionable particle size analyses of nondispersant soils, mineralogy, and organic matter levels affect usage of the soil erodibility nomographs.

g. Significant erosion on soils with less than 2 percent slopes, particularly coastal plain regions, need to be taken into account in soil loss predictions.

h. The validity of the Soil Loss Equation in watershed areas that have been severely disturbed, compacted, and translocated with exposed subsoil and parent materials is highly questionable.

i. Influences of coarse fragments, mineralogy, bi-sequum profiles, lithologic discontinuities, high salt content soils, and high organic matter content (>4%) relative to soil loss predictions are largely unknown entities.

j. Soil loss in areas of undisturbed surface conditions differ drastically after fires, or cultural alterations, even on desert landscapes. The important relationships of surface condition to erosion do not appear to be recognized fully nor accounted for in soil loss predictions.

k. Justification seems to exist for clearly separating normal yearly erosion from occurrences that may occur once in several years. An agricultural area may have rill erosion every year and slumps and slides one year in ten when conditions combine in the right sequence. It seems questionable that usage of the Universal Soil Loss Equation could adequately apply to both conditions.

l. For maximum utilization of this or other soil loss methods it seems essential that the method be capable of full utilization by non-soil scientists. Conservationists and other professionals must be able to recognize and reasonably compute the factors needed to make estimates in a consistent manner.

Current Developments

Several states are currently assigning or re-evaluating factors and values used in the Universal Soil Loss Equation. The U.S. Bureau of Land Management is initiating a study that could serve as the data source for development of "R" values in the states of Montana, Wyoming, Colorado, Utah, and New Mexico. The Agricultural Research Service is currently gathering data relative to "EI" and "R" factors in various geographical regions.

Use of Other Soil-Loss Prediction Methods

I. A method currently used by the U.S. Forest Service in some western states enables computation of a quantified soil erosion hazard rating and net soil loss to the channel system for watersheds in the Southwestern Region[1]. This procedure was adapted from Musgrove (1947), and it is basically a factorial approach. The procedure reportedly provides a more realistic coefficient for slopes greater than 30%. It also provides for soil cover density in terms of actual ground cover versus cover associated with a specific management intensity or crop use. It considers both splash and overland flow energy relationships.

II. The Bureau of Land Management, which manages approximately 160,000,000 acres, is currently utilizing a system of relative erosion rather than

[1]Anderson, D. A. 1969. Guidelines for Computing Quantified Soil Erosion Hazard and On-Site Soil Erosion. USDA, Forest Service, Southwestern Region. 30 pp.

quantification of soil loss. Reportedly, the system utilizes present visible factors to rate similar areas with a Soil Surface Factor from 1 to 100.

B. Assessment of Various Techniques for Measuring Sediment

Erosion losses from upland areas are not necessarily equivalent or directly related to sediment yields of a stream or other water body. Techniques for measuring sediment yield must account for the fact that channels may be a site of soil loss as well as deposition. It seems pertinent that evaluations of sediment yield be made with respect to different natural environmental conditions such as geology, soils, climate, runoff, topography, ground cover, and size of the drainage area.

Previously, concern has been directed toward fluvial sediments eroded via sheet and channel erosion. Due to complex irregularities of the land surface, sheet flow does not occur continuously over large areas but quickly concentrates into small rills or channels (Guy and Norman, 1970). Cultural disturbance of the natural landscape alters the complex variables affecting sediment erosion, transportation, and deposition necessitating more direct and indirect measurements of fluvial sediments (Guy and Norman, 1970).

Erosion rates for various sediment sources present a complex array of values (Table 1). Various recent estimates have been made relevant to total sediment deposited annually (Table 2).

Discussion

In the early 1900's investigators developed new equipment to measure sediment independently. There was little uniformity and precalibration was largely non-existent (Guy and Norman, 1970). Resultant data were difficult to compare and the validity was questionable. An interagency program was organized in 1939 by the U. S. Government to evaluate instruments used to measure sediment and to standardize equipment and methods. The early instruments used for sediment measurements were primarily suspended sediment, bedload, and bed materials samplers. An array of standard samplers and methods were developed by the Federal Interagency Sediment Project of the Interagency Committee on Water Resources located at Iowa City, Iowa, and since 1948 at Minneapolis, Minnesota (Guy, 1970).

Many of the standard instruments currently used to measure sediment were developed shortly after World War II and refined in subsequent years. Many of these instruments are capable of manually collecting point or single depth-integrated samples of suspended sediment at selected time intervals at cross-section locations. Sediment samplers currently recommended for field use include three depth-integrating suspended-sediment samplers, two point-integrating suspended-sediment samplers, and three bed-materials samplers. There are also single-stage samplers and pumping samplers to obtain data from streams (F.I.A.S.P., 1963). These instruments carry the following coded designation:

Table 1. Erosion Rates Reported for Various Sediment Sources[1]

Sediment Source	Erosion Rate Tons/mile^2/year	Geographic Location	Comment	Reference
Natural	15-20	Potomac River Basin	Native cover	62
	32-192		Native cover	76
	200	Pennsylvania and Virginia	Natural drainage basin	44
	320	Mississippi River Basin	Throughout geologic history	76
	13-83	Northern Mississippi	Forested watershed	83
	25-100	Northwest New Jersey	Forest and under-developed land	4
	115		Soils eroding at the rate they form	62
Agricultural	12,800	Missouri Valley	Loess region	67
	13,900	Northern Mississippi	Cultivated land	83
	1,030	Northern Mississippi	Pasture land	83
	10,000-70,000		Continuous row crop without conservation practices	27
	200-500	Eastern U. S. Piedmont	Farmland	96
	320-3,840		Established as tolerable erosion	76
Urban	50,000	Kensington, Maryland	Undergoing extensive construction	44
	1,000-100,000		Small urban construction area	96
	1,000	Washington, D.C. Area	750 mile^2 area average	62
	500	Philadelphia Area		
	146 280 690 2,300	Washington, D. C. Area Watersheds	As urbanization increases	2

Table 1 cont'd

Sediment Source	Erosion Rate Tons/mile²/year	Geographic Location	comment	Reference
Highway Construction	36,000	Fairfax County, Virginia	Construction on 179 acres	90
	50,000-150,000	Georgia	cut slopes	26

[1]From page 11: The Dow Chemical Company. 1972. An Economic Analysis of Erosion and Sediment Control Methods for Watersheds Undergoing Urbanization. National Technical Information Service, U. S. Department of Commerce PB-209 212, Springfield, Virginia.

REFERENCES (Table 1)

62. Miller, F. P., "The Factors of Geology and Soils," in "Urban Sediment Can Be Controlled," Proc. Winter Mtg. Interstate Commission on Potomac River Basin, College Park, Md., February 17-18, 1966.

76. Smith, R. M., and Stamey, W. L., "Determining the Range of Tolerable Erosion," Soil Sci., 100. 414-424 (1965).

44. Guy, H. P., Ferguson, G. E., "Sediment in Small Reservoirs Due to Urbanization," Amer. Soc. Civil Eng., J., Hydr. Div., pp. 27-37 (March 1962).

83. Ursic, S. J., and Dendy, F. E., "Sediment Yields from Small Watersheds under Various Land Uses and Forest Covers," Proc. Federal Inter-Agency Sedimentation Conf., U. S. Dept. Agriculture, Misc. Publ. No. 970 (1963).

4. Anderson, P. W., and McCall, J. E., "Urbanization's Effect on Sediment Yield in New Jersey," J. Soil Water Conserv., 23 (4), 142-144 (1968).

67. Piest, R. F., and Spomer, R. G., "Sheet and Gully Erosion in the Missouri Valley Loessial Region," Amer. Soc. Agr. Eng. Trans., 11, 850-853 (1968).

87. U. S. Dept. Interior, Federal Water Pollution Control Administration, "The Cost of Clean Water and Its Economic Impact," Vol. I, June 10, 1969.

96. Wolman, M. G., and Schick, A. P., "Effects of Construction on Fluvial Sediment, Urban and Suburban Areas of Maryland," Water Resources Res., 3 (2), 451-464 (1967).

2. Anderson, G. B., "Soil and Water Conservation Comes to Suburban Fairfax County," in "Urban Sediment Can Be Controlled," Proc. Winter Mtg. Interstate Commission on Potomac River Basin, College Park, Md., February 17-18, 1966.

90. Vice, R. B., Guy, H. P., Ferguson, G. E., "Sediment Movement in an Ares of Suburban Highway Construction, Scott Run Basin, Fairfax County, Virginia, 1961-1964," Geol. Surv. Water Supply Pap. 1591-E. pp. El-E41, 1969.

26. Diseker, E. G., and Richardson, E. C., "Roadside Sediment Production and Control," Trans. Amer. Soc. Agric. Eng., 4, 62-64 (1961).

Table 2. Sediment Sources and Their Total Contribution To Sediment in Streams in the United States[1]

Sediment Sources	Total Sediment Million Tons Per Year
Roads	57
Mining	20
Agriculture	750
Urban	80
Pasture and Rangeland	230
Forest	
Federal Land	125
Other	15
Total Sediment to Streams	1,416
Stream Bank Erosion	500
Total Sediment	1,916*

[1]From page 15: The Dow Chemical Company. 1972. An Economic Analysis of Erosion and Sediment Control Methods for Watersheds Undergoing Urbanization. National Technical Information Service, U. S. Department of Commerce PB-209 212, Springfield, Virginia.

*Total sediment is sometimes reported as about 4 billion tons/year for the United States.

US - United States standard sampler
D - Depth integrating
P - Point integrating
H - Hand-held by rod or rope, for cable and reel suspension the H is omitted
BM - Bed material
U - Single stage
YEAR - Year (last two digits) in which the sampler was developed

Suspended-Sediment Sampler - To obtain a sample that is representative of the water-sediment mixture moving in the stream.

Depth-Integrating Sampler - To accumulate a water-sediment sample from a stream vertical at such a rate that the velocity in the nozzle at the point of intake is the same as the immediate stream velocity, while running the vertical at a uniform speed.

Point-Integrating Sampler - Obtain a depth-integrating sample from deep or swift streams by holding the value open while integrating the stream depth.

Bed-Material Sampler - Collect bed-material samples of particles less than about 30 to 40 mm in diameter.

Recently, instruments such as automatic-pumping sediment samplers, the neutron gage, and turbidity meter have been developed and utilized to measure sediments.

Synopsis of Subcommittee Comments

a. Delivery ratios have been developed for some physiographic areas and related to watershed characteristics. Unfortunately, the few areas investigated represent a very small portion of the United States.

b. The time factor related to sedimentation and the depositional distribution are very important for a systems analyses. It is desirable to know how much sediment a watershed contributes in a given period of time.

c. There is a lack of coordinated effort to collect sediment yield data for various types of watersheds over an extended period of time.

d. Past systems have relied on stream guage data to characterize watershed hydrology. There are more parameters in the watershed requiring quantification. Soil and geomorphic features drastically affect the hydrologic and sedimentation processes in watersheds.

e. Inconsistencies occur in the use of sediment delivery ratios when applied to gross erosion estimates for obtaining sediment yield. Delivery ratio curves are useful for determining single-point yield estimates; however, efforts to use them relative to sediment routing combination in watersheds is of questionable validity.

f. Concern exists relative to the adaptation of soil loss and sediment yield equations developed primarily for agricultural lands and applied to urban development areas.

g. Sediment rating curves, reservoir sediment deposition surveys, gross erosion equations, and sediment delivery ratios provide estimates of the total sedimentation at a site, but they do not indicate sources or distribution. Sediment yield models that interface with both hydrologic and chemical transport models need to reflect both the source of sediment and its relative size distribution.

h. Sediment accumulation on flood plains can be recognized by aerial photography and supplemented by field examinations to determine depth and characteristics of the depositions. Other types of remote sensing imagery offer significant promise as techniques to document specific sedimentation and movement utilizing automatic data processing.

i. The development of adequate sediment measuring equipment and techniques is largely dependent on understanding the complete environmental system of the watershed area. It is essential to understand the distribution of sediment in the flow.

j. Consideration is urged for the rapid integration of existing remote sensing techniques and automatic data processing methodology to sedimentation detection and measurement systems on a routine basis.

Subcommittee Members:

D. E. Pettry, Subcommittee Chairman, Blacksburg, Virginia
J. L. Hunt, Upper Darby, Pennsulvania
C. S. Holzhey, Beltsville, Maryland
*R. B. Daniels, Raleigh, North Carolina
B. Birdwell. Ft. Worth. Texas
F. P. Miller, College Park, Maryland
B. R. Smith, Clemson, South Carolina
*L. H. Rivera, San Juan, Puerto Rico
*O. F. Bailey, Honolulu, Hawaii
G. L. Richard, Spokane, Washington
J. P. Culver, Lincoln, Nebraska
R. L. Kuhlman, Washington, D.C.
W. M. Edwards, Coshocton, Ohio.
B. J. Miller, Baton Rouge, Louisiana

*Present at Conference

REFERENCES UTILIZED

Anderson, D. G. 1963. Effects of Urbanization on Floods in Northern Virginia. U. S. Geol. Survey Prof. Paper 475-A, A-69.

Barfield, B. J. and C. T. Haan. 1972. Erosion Sediment Production. "Proceedings Urban Rainfall Management Problems, U. of Kentucky, Technical Report UKy 51-72-CE16, June 1972.

Benedict, P. C. and D. Q. Matejka. 1953. The measurement of total sediment load in alluvial streams. IN Proceedings of the Fifth Iowa Hydraulics Conference, Eng. Bull. 34. Iowa Univ., Iowa City, Iowa, pp 263-286.

carter, R. w. 1961. Magnitude and frequency of floods in suburban areas. IN Short papers in the geologic and hydrologic sciences: U. S. Geol. Survey Prof. Paper 424-B, pp B9-B11.

Colby, B. R. 1956. Relationship of sediment discharge to streamflow: U. S. Geol. Survey Open-File Rep., 170 pp.

Colby, B. R. 1963. Fluvial sediments--a summary of source, transportation, deposition, and measurement of sediment discharge. u. s. Geol. survey Bull. 1181-A, 47 pp.

Colby, B. R. and D. W. Hubbell. 1961. Simplified methods for computing total sediment discharge with the modified Einstein procedure. U. S. Geol. Survey Water-Supply Paper 1593, 17 pp.

Crippen, J. R. 1965. Changes in character of unit hydrographs, Sharon Creek, California, after suburban development. IN Geological Survey research 1965: U. S. Geol. Survey Prof. Paper 525-D, pp. D196-D198.

Espey, W. H. K., C. W. Morgan, and F. D. Masch. 1966. Study of some effects of urbanization on storm runoff from a small watershed. Texas Water Devel. Board Rept. 23, 110 pp.

Federal Interagency Sedimentation Project. 1963. A summary of the work of the Federal Interagency Sedimentation Project. Interagency Report S: Minneapolis, Minn., St. Anthony Falls Hydraulic Lab., 29 pp.

Federal Interagency Sedimentation Project of the Interagency Committee On water Resources. 1966. Instruments and Reports for Fluvial Sediment Investigations Interagency Report Catalog. Minneapolis, Minn., St. Anthony Falls Hydraulics Lab., 67 pp.

Foster, G. R. and L. D. Meyer. 1972a. A Closed-Form Soil Erosion Equation for Upland Areas. Sedimentation (Einstein): 12-1 to 12-9.

Foster, G. R. and L. D. Meyer. 1972b. Transport of Soil Particles by Shallow Flow. Trans. ASAE 15(1):99-109.

Foster, G. Pi. and W. H. Wischmeier. 1973. Evaluating Irregular Slopes for Soil Loss Prediction. Paper No. 73-227 Amer. Soc. Agr. Engineers, 1973 Annual Meeting, Lexington, Kentucky, 15 pp.

Guy, H. P. and G. E. Ferguson. 1962. Sediment in small reservoirs due to urbanization. Proc. Amer. Civil Engr. Vol. 88(HY2):27-37 (J. Hydraul. Div.).

Guy, H. P. and V. W. Norman. 1970. Field Methods for Measurement of Fluvial Sediment. Techniques of Water-Resources Investigations of the United States Geological Survey. U. S. Department of the Interior. U. S. Gov't. Printing Office, Washington, D.C., 59 pp.

Harris, E. E. and S. E. Rants. 1964. Effect of urban growth on streamflow regimen of Permanente Creek, Santa Clara County, California. U. S. Geol. Survey Water-Supply Paper 1591-B, 18 pp.

Holeman, J. N. 1968. The sediment yield of major rivers of the world. Water Resources Research V. 4, No. 4, pp. 373-477.

Holeman, J. N. and A. F. Geiger. 1959. Sedimentation of Lake Barcroft, Fairfax County, Virginia. TP 136, U. S. Soil Conservation Service, p. 1.

Leopold, L. B. 1972. Hydrology for Urban Land Planning - A guidebook on hydrologic effects of urban land use. U. S. Geol. Survey, Washington, D. C., 18 pp.

Leopold, L. B. and T. Maddock, Jr. 1953. The hydraulic geochemistry of stream channels and some physiographic implications. Professional Paper 252, U. S. Geol. Survey.

Meyer, L. D. and L. A. Kramer. 1969. Relation Between Land Slope Shape and Soil Erosion. ASAI Paper No. 68-749. Ag. Eng. 50(9):522-523.

Meyer, L. D. and W. H. Wischmeier. 1969. Mathematical Simulation of the Process of Soil Erosion by Water. Ag. Eng. 12(6):754-758.

Musgrave, G. W. 1947. The Quantitative Evaluation of Factors in Water Erosion, A. First Approximation. J. Soil and Water Conserv. 2(3):133-138.

Onstad, C. A., C. L. Larson, L. F. Hermsmeier, and R. A. Young. 1967. A Method for Computing Soil Movement Throughout a Field. Trans. ASAE 10(6):742-745.

Parson, D. A. 1954. Coshocton-Type Runoff Samplers. USDA, SCS, T.P. 124.

Peterson, H. V. 1962. Hydrology of small watersheds in western states. U. S. Geol. Survey Water-Wupply Paper 1475-1, pp. 223-227.

Porterfield, G. 1970. Computation of fluvial sediment discharge. U. S. Geol. Survey Tech. of Water Resources Investigations, Book 5, Chap. C2.

Schumm, S. A. 1961. Effect of Sediment Characteristics on Erosion and Deposition in Ephemeral Stream Channels. Professional Paper 352-C, U. S. Geol. Survey.

Seaburn, G. E. 1969. Effects of urban development on direct runoff to East Meadow Brook, Nassau County, Long Island, N. Y. U. S. Geol. Survey Prof. Paper 627B, 14 pp.

Smith, D. D. and D. M. Whitt. 1948. Evaluating Soil Losses from Field Areas. Agr. Eng. 29(9):394-396.

Snyder, W. M., W. C. Mills, and J. C. Stephens. 1970. A Method of Derivation of Non-Constant Watersheds Response Functions. Water Resources Research, Vol. 6, No. 1, pp. 261-274.

The Dow Chemical Company. 1971. An Economic Analysis of Erosion and Sediment Methods for Watersheds Undergoing Urbanization (C-1677), Final Report, February 15, 1971.

Tholin, A. L. and C. J. Keifer. 1960. Hydrology of Urban Runoff. Transactions, ASCS, Vol. 125, p. 1308.

Vanoni, V. A. 1969. Sediment Measurement Techniques: A. Fluvial Sediment. J. of the Hydraulics Division, ASCE Proc. 95:1477-1514.

Van't Woudt, B. D. and Goro Uehara. 1961. Erosion Behavior and Control on a Stripmined Latosolic Soil, Hawaii Agricultural Experiment Station, University of Hawaii, Tech. Bull. No. 46, October 1961.

Waananen, A. O. 1961. Hydrologic effects of urban growth--some characteristics of urban runoff. IN Short papers in the geologic and hydrologic sciences. U. S. Geol. Survey Prof. Paper 424-C, pp. ~353-356.

Wiitala, S. W. 1961. Some aspects of the effects of urban and suburban development upon runoff. U. S. Geol. Survey open file report, 28 pp. 9 figs.

Williams, J. R. and J. D. Berndt. 1972. Sediment Yield Computed with Universal Equation. J. Hydraulics Division, Proc. ASEE, No. HY12, 2087-2097, December 1972.

Wischmeier, W. H. 1971. Approximating the Erosion Equation's Factor C for Uncultivated Land Areas. Unpublished Report of ARS-SCS Technical Conference, Des Plaines, Illinois, Nov. 22-24, 1971.

Wischmeier, W. H. C. B. Johnson; and B. V. Cross. 1971. A Soil Erodibility Nomograph for Farmland and Construction Sites. J. Soil and Water Conserv. 26(5):189-193.

Wischmeier, W. H. and D. D. Smith. 1958. Rainfall energy and its relation to soil loss. Transactions, Amer. Geophysical Union, Vol. 39, No. 2, p. 285.

Wischmeier, W. H. and D. D. Smith. 1960. A Universal Soil Loss Equation to Guide Conservation Farm Planning. Trans. 7th International Congress of Soil Sci., Madison, Wisconsin.

Wischmeier, W. H. and D. D. Smith. 1965. Predicting Rainfall-Erosion Losses from Cropland East of the Rocky Mountains. Agr. Handbook No. 282, U. S. Dept. of Agr. 47 pp.

Wolman, M. G. 1964. 'Problems posed by sediment derived from construction activities in Maryland. Report to the Md. Waste Poll. Control Commission Water Resource Res. 1:451-462.

Wolman, M. G. and P. A. Schick. 1967. Effects of construction on alluvial sediment, urban and suburban areas of Maryland. Water Es. Res. 3:451-464.

Young, R. A. and C. R. Mutchler. 1969. Soil Movement on Irregular Slopes. Water Resources Res. 5(5):1084-1089.

SUBCOMMITTEE B

1975 NATIONAL SOIL SURVEY CONFERENCE

ON

TECHNIQUE3 FOR MEASURING SOURCE AND YIELD OF SEDIMENT FROM CONSTRUCTION AREAS, MINING AREAS, AND CRITICAL ERODING AREAS OR POINT SOURCES

Subcommittee Charge: Assess the various techniques that can be used to measure the yield of sediments from sources such as construction areas, mining areas, and critical eroding areas or point source8 from areas of active erosion.

The amount of data now being collected on erosion and sediment yield from construction areas, mining areas, and critical eroding areas is meager relative to our needs. The ability to estimate with reasonable accuracy the sediment yield from such areas is important in:

a. convincing land owners, developers, local governments, and others of the need for and value of practices to minimize erosion;

b. evaluating or demonstrating the need for replacement of topsoil on construction sites;

c. the development of minimum standards for erosion control practices;

d. the design of sediment basins, sediment pools, and sediment storage in reservoirs, and to highlight the need for land treatment above reservoirs.

Two major kinds of data collection activities are recognized:

a. those that require elaborate or expensive measurements of a kind normally conducted by major research institutions,

b. those that require inexpensive measurements which might be made on many kinds of soil by workers of SCS and other agencies as part of their regular field activities.

This report deals separately with each of these two kinds of activities.

I. Elaborate or expensive measurements of erosion and sediment yield.

The subcommittee recognizes the value of recent work at Purdue University and other research institutions in measuring runoff and erosion from scalped areas and fills in elaborate and relatively expensive studies. Data developed through such studies should be assembled, by kind of soil, at the national level as the work is completed.

II. Inexpensive measurements of erosion and sediment yield.

The subcommittee brain-stormed the identification of methods of collecting useful data by inexpensive measurements. Numerous approaches were evaluated for measuring erosion loss at sites and for evaluating sediment in streams, basins, and reservoirs

III. List of references.

The list was assembled by the subcommittee to include most of the leading recent work in erosion and sedimentation that has been published.

LIST OF REFERENCES

Measuring Erosion and Sediment
Yield in Critical Eroding Areas

1. Erosion and Sedimentation Methodology Task Force. 1974. Task Force Report, Mimeo. Water Management Subcommittee of the Pacific Southwest Interagency Committee. Available through Elliott M. Flaxman, SCS, West Technical Service Center, 511 N.W. Broadway, Portland, Oregon 97209.

2. Guy, H. P. and Jones, D. Earl, Jr. Urban Sedimentation in Perspective. Journ. of the Hydraulics Division, ASCE, Vol. 98, No. HY12, Proc. Paper 9420, December 1972. PP. 2099-2116.

3. __________ and V. W. Norman. 1969. Field Methods for Measurement of Fluvial Sediment: U. S. Geol. Survey Techniques - Water Resources Investigations. Book 3, Chapter C2.

4. Highway Research Board. 19'73. Soil Erosion: Causes and Mechanisms for Prevention and Control. HRB Special Report 135, 2101 Constitution Avenue, N.W., Washington, D.C.

5. Huntington, G. L. 1973. Environmental Factors and Soil Properties Determining the Erodibility of California Soils. Mimeo. report of activity during 1973. Univ. of California, Davis.

6. Jones, L. A. 1972. Soluble and Suspended Pollutants from Three Agricultural Watersheds in Maumee River Basin. Unpub. M.S. Thesis. The Ohio State University, Columbus, Ohio 43210.

7. Judson, S. 1968. Erosion of the Land. American Scientist 56:356-374.

a. __________ and D. F. Ritter. 1964. Rates of Regional Denudation in the United States. Journ. of Geophysical Research 69:3395-3401.

9. Leopold, Wolman, and Miller. 1964. Fluvial Processes in Geomorphology. W. H. Freeman and Co.

10. McGregor, K. C., *et al*. 1969. Runoff and Sediment Production from North Mississippi Loessal Soils. Agr. Expt. Station Bull. 77. Mississippi State University. 30 PP.

11. Meyer, L. D. 1971. Soil Erosion by Water on Upland Areas - River Mechanics. Ft. Collins, Colorado. Chapt. 27.

12. __________, W. H. Wischmeler, and W. O. Daniel. Erosion, Runoff and Revegetation of Denuded Construction Sites. Amer. Soc. Agr. Eng. Trans., 14, No. 1, 138-141 (1971)

13. __________, C. B. Johnson, and G. R. Foster. 1972. Stone and Woodchip Mulches for Erosion Control on Construction Sites. Journ. of Soil and Water Conservation 27:No. 6.

14. Miller, C. R. and A. J. Bowie. 1965. Sediment Sampling: Instrumentation and Techniques. Transactions of ASAE 8:(2) 267-274.

15. Mutchler, C. K. 1965. Runoff Plot Design and Installation for Soil Erosion Studies. ARS 41-79, Agricultural Research Service, Washington, D.C.

16. Pacific Southwest Interagency Committee. 1974. Report of the Water Management Subcommittee on Erosion and Sediment Yield Methods.

17. Parsons, D. A. 1961. A Note on the Erosive Potential of Rainfall. Research Report No. 347, U. S. Sed. Lab., Southern Branch. Soil Conservation Service, Washington, D.C.

18. Subcommittee on Sedimentation, Interagency Committee on Water Resources. 1963. A Study of Methods Used in Measurement and Analysis of Sediment Loads in Streams. Report No. 14, St. Anthony Falls Hydraulics Lab., Minneapolis, Minn. pp. 129-132.

19. Task Committee on Preparation of Manual on Sedimentation. 1969. Sediment Measurement Techniques: A. Fluvial Sediment. V. A. Vanoni, Chairman, Journal of the Hydraulics Div., ASCE Proc. 95:1477-1514. September 1969.

20. __________. 1970. Sediment Engineering, Chapter IV: Sediment Sources and Sediment Yields. V. A. Vanoni, Chairman, Journal of the Hydraulics Div., ASCE Proc. 96:1283-1329. June 1970.

21. Youngberg, C. T. et al. 1971. Hills Creek Reservoir Turbidity Study. Report No. 14, Oregon Water Resources Research Institute, Corvallis, Oregon.

22. Wall, G. J. 1973. Sediment and Solution Parameters in the Maumee River Basin, Ohio. Unpub. PhD Thesis, Ohio State University, Columbus, Ohio 43210.

23. Walter, L. S. 1973. Remote Sensing of Environmental Pollution. Second Joint Conference on Sensing of Environmental Pollutants. Sheraton Park Hotel, Washington, D.C. December 1973.

24. Williams, J. R. and H. D. Berndt. 1972. Sediment Yield Computed with Universal Equation. Journ. of Hydraulics Div., ASCE Proc. 98:2087-2098, December 1972.

25. Wischmeier, W. H., C. G. Johnson, and B. V. Cross. 1971. A Soil Erodibility Monograph for Farmland and Construction Sites, Journ. Soil and Water Cons. 26:189-193.

Subcommittee Members:

J. U. Anderson, New Mexico State University
• R. C. Carter, SCS, Mississippi
N. M. Curtis, SCS, Portland, Oregon (replacing Mr. Flaxman)
R. L. Guthrie, SCS, Lincoln, Nebraska
J. W. Hawley, SCS, Texas
*R. D. Heil, Colorado State University
J. N. Holeman, SCS, Washington, D.C.
R. B. Jones, Ohio Department of Natural Resources, DLS
G. J. Latshaw, SCS, Pennsylvania
*G. J. Post, SCS, Ohio
R. L. Shields, SCS, Maryland
B. R. Smith, Clemson University
R. M. Smith, West Virginia University
A. R. Southard, Utah State University

D. E. McCormack, Chairman, SCS, Washington, D.C.

*Present at Conference

NATIONAL SOIL SURVEY CONFERENCE
ORLANDO, FLORIDA. JANUARY 26-31, 1975
REPORT OF THE COMMITTEE ON CLASSIFICATION OF SOILS
RESULTING FROM MINING OPERATIONS AND THE INTERPRETATIONS

Charges for the committee were as follows:

1. Develop criteria and field and laboratory techniques for classifying soils on mine spoil and other areas affected by mining operations at appropriate levels of the taxonomic system.

2. Develop criteria for interpreting soils for the optimal use and treatment of land affected by mining operations.

Introduction

Mapping units of soils in materials resulting from surface mining operations have been classified as miscellaneous land types in soil surveys completed earlier than a few years ago. Examination of the soils involved was superficial in most of these surveys and relatively little specific information was gathered on the soil properties. Most napping units were named as Strip mines, Strip mine spoil, Mine land, Mine pits and dumps, and the like, or as simple subdivisions of such miscellaneous land types. Some surveys completed in the 1960's separated as many as six to ten different mapping units of Strip mine spoil, distinctions between mapping units being based on slope, texture, reaction, and lithology of the soil material.

Interest in soils in mine spoils has increased substantially during the past several years. This has been stimulated in part by increased surface mining activity and more Interest in reclamation of mined land. Many detailed descriptions of soils in mine spoils have been written during this latter period. The work in West Virginia, Ohio, and Pennsylvania in particular is known to the committee.

Recent estimates (SCS Advisory CONS-6, 3/26/74; re: Status of Land Disturbed by Surface Mining as of January 1, 1974, by States) indicate that the total area disturbed by surface mining in the U.S. is near 4.4 million acres and that roughly 40 percent of thatis due to coal mining. Those estimates indicate that the total area disturbed increased nearly 40 percent between 1965 and 1974. The increase during the last two years was at about that same rate, but it is expected to be greater in the future.

The 1974 Regional Soil Survey Conferences of the Northeastern States and of the Western States each included a committee that dealt with this subject. The reports of those committees were considered by this national committee and they are discussed in this report.

Classification of Soils on Mine Spoil

Discussions of the classification of these soils have involved two separate but closely related questions:

A. How should the soils be handled in the Soil Taxonomy7

1. Can they be classified adequately for the objectives of the soil survey within the present framework of classes of Soil Taxonomy, or

2. Should they be brought together in a separate class in a high category of the classification system?

B. HOW should mapping units of these soils be identified and named in soil surveys? Again, two alternatives have been considered in current thinking:

1. Name mapping units as phases of classes in high categories of the classification system.

2. Identify and name mapping units as phases of series or of soil families.

These questions and the alternatives are considered in the following paragraphs.

There appears to be rather wide agreement that the soils in question should be included in Entisols. The current definition of the cambic horizon poses a problem in this regard, and that is discussed in a later paragraph.

A. Classification at the Suborder Level

For classification at the suborder and lower categorical levels, two different approaches have support among the committee members and others who have made their views known to the committee. A consensus in favor of either of the alternatives was not evident. One approach would attempt to bring together at the suborder level soils on mine spoils and on other materials recently deposited by man, such as sanitary land fills, earth fills, and other deposits of earthy materials. The rationale is that man has been the most important soil forming factor and is the common denominator for these soils. The other approach is to classify the soils in the current classes of Soil Taxonomy, as has been done in many surveys completed within the last several years.

A proposal from West Virginia University to bring together the subject soils in a new suborder, Spolents, is outlined in Appendix A. The formative element "spol" in the name is from the Latin, spoliare--to spoil. Spolents meet the criteria for Entisols and criteria 1, 2, and 4 of Orthents, but they may or may not meet criterion 3 of Orthents, which concerns slops and organic matter in relation to depth. In addition, Spolents must have at least three of the six criteria listed below (abbreviated here --see Appendix A for cauplete statements).

1. If coarse fragments an? at least 10 percent by volume, they are disordered such that more than 50 percent have their long axis at an angle of at least 10 degrees relative to any plane in the soil.

2. Color mottling is present and is not related to depth or is not regularly spaced in the soil.

3. The edges of fissile coarse fragments are frayed or splintery rather than smooth.

4. Coarse fragments bridge voids that result in discontinuous irregular pores larger than the texture porosity.

5. A surface horizon, or a horizon immediately below a surface pavement of coarse fragments, that is 1 to 4 inches thick contains more of the less than 2 mm fraction than any other layer to a depth of 40 inches.

6. Local pockets of contrasting materials, excluding single coarse fragments, that range in horizontal dimensions from 3 to 40 inches are present.

Great groups of Spolents are set apart on the basis of soil temperature and moisture regimes as Udispolents, Ustispolents, etc., in a fashion parallel to the great groups of Orthents and Fluvents. Subgroups are distinguished mainly on lithology of coarse fragments in the control section, but the proposal recognizes that additional subgroup criteria may be needed in other regions. Family classes for particle size, mineralogy, soil temperature, and modified soil reaction classes are used to set apart families.

In commenting on the use of character of the coarse fragments to set apart subgroups of Spolents, the Northeast Regional Committee on Highly Disturbed Soils noted:

> "The emphasis on coarse fragments at a high level of classification is believed Justified by the fact that minesoils are created from more or less fractured and disintegrated rocks which automatically assume a major role in determining genetic processes as well as use potentials and management requirements of these soils."

The report of the Northeast Regional Committee also suggested the following:

> "In order to exclude minesoils from certain high level classification categories and to assure their placement under the more meaningful proposed suborder of Spolents,

it appears necessary to make some minor changes in the definitions of several suborders of Entisols and perhaps in the minimum requirements for a cambic horizon, as follows:

1. Arents should require at least 20 percent by volume of fragments of diagnostic horizons in the soil below any A horizon.

2. Aquents should include an insert that the period of saturation during the year should be 30 days or longer (or some other extended minimum period of wetness).

3. Fluvents should include stratification within one meter of the surface as an essential part of the definition. Also, irregular carbon content with depth should be associated with observable stratification, at least in some part of the profile.

4. Orthents should include an insert that they have less than 20 percent (volume) of fragments of diagnostic horizons, etc., as written in item 2 of the definition. In addition, the definition should include a statement as follows: "do not include more than 2 of the 6 properties listed for definition of Spolents in addition to the 4 Items used to define Orthents.

5. Cambic horizon6 should require some property in addition to weak structure. A6 suggested by Dr. John E. Witty, in his response to Subcommittee 3 of Committee 7, a satisfactory criterion might be, "peds distinct enough that crushing them result6 In a perceptible change of color." In this connection, it should be emphasized that the crushing should exclude all rock fragments, some of which may be weak enough to crush readily with the fingers."

The proposed suborder of Spolents is appealing to many individuals because it serves to flag man's influence on the character of the soils and distinguishes them from other "natural" Entisols. With the present classes and definitions in Soil Taxonomy, the soils in question are distributed among the five suborders of Entisols plus Ochrepts and probably Aquepts.

The five suggestions of the Northeast Regional Committee that are quoted above seemingly would improve the distinction between the proposed Spolents and other suborders, but some problem6 remain to be solved. Problems that have been identified include the following:

a. It does not seem feasible to define Spolents to include all Entisols that have resulted directly from man's activities without eliminating the suborder Arents, yet keeping the "ran-made" soil6 together seems to be the strongest reason in support of the proposed new suborder. The probability that a significant volume of fragments of diagnostic horizons will be present in the 10 to 40 inch section depends on several things, including: thickness, coherence, and physical strength of the diagnostic horizons at the time they were disturbed; thickness of the section disturbed or moved; the machines used and the procedure of the earthmoving operation. In this respect, the Implications of an overburden 12 to 15 feet thick, as for phosphate mining in Florida, compared to overburdens 50 to 80 feet thick, as for some coal mining in the Appalachian Plateaus, Illinois, and the northern Great Plains, are clear. At the same time, mining procedures aimed at reclamation, such as stockpiling favorable soil materials and placing material from the upper part of the regolith In the uppermost part of the overburden spoil, increase the probability that a significant volume of fragments of diagnostic horizons will be present in the new soil, even if the overburden is very thick.

A large proportion of soils in mine overburden spoils evidently lacks consistently identifiable fragments of diagnostic horizons in the 40 inch section. Limited field studies in Florida and Illinois indicate that fragments of diagnostic horizons are present in many pedons but at the same time are not usually present in soils in those areas. The classification of mapping units of soils in spoil material6 evidently would be simplified if the definition of the suborder Arents were changed to require a minimum volume of fragments of diagnostic horizons in the 10 to 40 inch section. A limit of 20 percent by volume, as suggested by the committee of the Northeast Region, appears to be reasonable with respect to the goal of keeping most soils in surface mining overburden spoils in one suborder. The limit needs to be tested on soils that have been altered by deep plowing and by removal of hardpans to see if it would leave room for a useful suborder of Arents. If the limit were set at 20 percent of the 10 to 40 inch section and fragments of diagnostic horizons were identifiable in only part of that section, the required proportions for that part become quite high; for example:

Horizon Thickness	Volume Required
24 inches	25 percent
18 inches	33 percent
15 inches	40 percent
12 inches	50 percent
10 Inches	60 percent

It should be noted that the question of setting a limit on the proportion of fragments of diagnostic horizons required for Arents is the same whether or not the proposed suborder of Spolents is recognized.

b. Soils in "tailings" and "slimes," which are byproducts of ore processing plants, logically should be included in Spolents, if the objective is to keep man-made soils together, but it is not clear how that could be done using criteria that are soil properties. The parent materials of these soils were deposited from water suspension end therefore have many characteristics of natural sediments. Many of the soils in question classify as Aquents, Psamments, or Orthents by the present criteria of Soil Taxonomy end they are not included in Spolents by the suggested criteria. It seems likely that fill materials from hydraulic dredging would also be difficult to include in the proposed Spolents for similar reasons. The present exclusion of many man-made soils from the proposed Spolents seems to weaken the main argument for proposing the new suborder.

c. The criteria for the proposed suborder of Spolents depend heavily on the presence of coarse fragments in the soil. Pour of the six criteria are concerned with coarse fragments. Consequently, the criteria do not work well for soils having low amounts of coarse fragments. Although a high content of coarse fragments and stones is the usual condition in soils in coal mine overburden spoils in the Appalachian Plateaus, this is not true of all mine spoils. In areas where the uppermost 5 to 10 feet or more of the natural rego-11th contain little stone, mining procedures aimed at reclamation can produce a soil with a very small proportion of coarse fragments. Such soils are not uncommon in coal mine spoils in Illinois, for example.

On the other hand, the criteria of color mottling independent of depth and spacing in the profile (criterion 2) and of discontinuous pockets of contrasting materials (criterion 6) do seem to be characteristic of soils in mine overburden spoils; at least, exceptions have not come to the attention of the committee. Those features, however, are not characteristic of the soils discussed in item b. above.

The authors of the proposal outlined in Appendix A are aware of the limitations of some of the proposed criteria end they are working to devise criteria that would be useful more generally.

d. Whether or not stratification within 1 meter of the surface can be made definitive for Fluvents, as suggested by the Northeast Regional Committee, without upsetting that grouping is e moot question. Presumably, fine stratification of e few millimeters, more or less, was meant. In a sample of 12 series descriptions of Fluvents, half were silent regarding the presence or absence of fine or thin stratification within the 40 inch section. The proposed criterion needs more thorough testing before it can be recommended for adoption. A number of soils on mine overburden spoils have slopes less than 25 percent end organic carbon content that decreases irregularly with dept. Consequently, the question needs to be dealt with whether the soils are classified as Orthents or es Spolents.

e. The proposal to make lithology of the coarse fragments diagnostic at the subgroup level is a large departure from the way that feature is now handled in Soil Taxonomy. With few exceptions, differences in mineralogical composition related to lithology of the parent materials are diagnostic in the series or family categories. We do not find a compelling reason to depart from the guidelines in the current Soil Taxonomy with respect to lithology of coarse fragments in soil.

f. A weak or moderate grade of soil structure extends to depths greater than 10 inches in a significant proportion of soils in mine spoils. By strict application of the current criteria of Soil Taxonomy, these soils have cambic horizons and belong with Ochrepts. Many of the 60116 involved are young--only 10 to 20 years old--and horizonation appears to be very weak. Most people who have expressed an opinion to the committee think the soils in question here should be placed in the same classes as other-vise similar Entisols in mine spoils of similar ages.

This would require amending the definition of cambic horizon to require some evidence of alteration in addition to the presence of soil structure.

Note that the question with respect to cambic horizons needs to be dealt with whether or not the proposed suborder of Spolents is recognized.

The committee on land altered by mining operations of the Western Regional Conference considered classification of the soils involved as Orthents and as Arents and reported a nearly unanimous conclusion that they should be classified as great groups of Orthents. Their rejection of a proposal to classify the soils as Arents followed from their belief that this would seriously complicate the classification and mapping of soils involved.

B. Identification and. Naming of Mapping Units

Currant proposals for identifying and naming mapping units range from phases of suborders to phases of series.

The attached legend of mapping units in Warwick County, Indiana, (Appendix B) illustrates classification and naming as phases of the suborder Orthents.

The Western Regional Committee recommended that the lowest level of classification should be phases of great groups, using the terminology for soil family class criteria to identify phases. They further recommended that only the following particle size class terms be used: sandy, sandy-skeletal, loamy, loamy-skeletal, clayey, clayey-skeletal, and fragmental. The Western Conference also thought that users of soil surveys ought to know from the name of the mapping units that the soils have been altered by mining. A suggestion to name such mapping units as "Mined land, Loamy Cryorthents," for example, was favorably received by the Western Regional Conference.

The attached legend for Belmont County, Ohio (Appendix C), illustrates a survey where the mapping units are phases of soil families. me 16 mapping units are given descriptive names. If common names for soil families were established, as suggested in the proposal from West Virginia, these mapping units could be named as phases of soil families.

The Northeastern Regional Committee proposed that mapping units be identified and named as soil families, using common soil family names, as in the proposal from West Virginia (Appendix A). A hypothetical mapping unit name with this approach might be "Cuzzart family, 8 to 25 percent slopes."

lastly, soils in mine spoils have been classified as soil series and mapping units have been named as phases of those series in several surveys in Oklahoma and one in Alabama. Descriptions of the Kanima and Palmerdale series, which were established for those surveys, are in Appendix D.

A number of individuals have expressed misgivings about proposals to identify and name mapping units of soils in mine spoils at the series level. Some doubt the practicality of mapping and classifying these soils at the family level. The questions stem from uncertainty that useful mapping units can be designed and accurately mapped at those low categorical levels in view of the heterogeneity of many mine spoil materials. There is concern that the time and effort required to accurately map the soils at low categorical levels may be excessive in relation to that spent mapping natural soils.

Mapping soils in mine overburden spoils at the family level is currently being tested in several soil surveys in Ohio and West Virginia. These surveys are said to be working out quite well thus far. The legends are providing a basis for more detailed observations of sets of properties of the soils and for recording them systematically.

It seems proper to propose series for soils in mine spoils and to test the idea of mapping and classifying such soils at the series level. In those instances, however, the soils need to be examined more systematically than would be necessary for natural soils to establish the validity of the series classification or the lack of validity of the classification. Without such a systematic examination, there is real risk of having: (a) some series names that represent classes in the taxonomic system and (b) other series names that simply identify mapping units consisting of an assortment of soil materials. If that were to happen, the net effect would be a down-grading of our classification of soils.

Two Ideas seem important for decisions on the categorical level at which soil mapping units are Identified and named:

1. If we identify and classify soils only in classes of high categories of the classification system, relatively few soil properties in relatively broad classes are controlled by the classification. Consequently, interpretations based on the classification must be in broad and general terms. Ranges in a few properties that are of importance for expected uses can be narrowed by setting apart

phases of the broad taxonomic classes, so that more specific end more useful interpretations of the mapping units can be made. In this situation we rely, for the most part, on the general body of knowledge of soil science to make interpretations of mapping units of individual soil surveys. This is the approach we have used in most surveys of surface mine spoils, whether the mapping units have been identified as phases of a miscellaneous land type or as phases of Orthents.

2. On the other hand, if we want to transfer experience on the behavior of the soils from one place to another on the basis of a whole set of narrowly defined soil characteristics, we seemingly will need to identify mapping units of soils in mine spoils as phases of soil families, or perhaps even as phases of soil series. Such classes could serve as a basis for collecting specific data on behavior of kinds of soils and for predicting the behavior of similar soils elsewhere, as we do now for soil series and soil families of natural soils.

Interpretations

Two topics were considered by the committee. One concerns the suitability of natural soil materials and other overburden materials as final cover for reclamation of mined land. The second concerns Interpretations of soils resulting from mining operations.

A. Suitability Ratings of Soils for Use as Final Cover for Mined Land

Most states now require a reclamation plan before permits or licenses for surface mining are issued. Reclamation requirements vary a great deal among states, but some include statements about the character of the material used as final cover of mined land.

A detailed soil survey and a geological survey of the area prior to surface mining provide much basic information needed for reclamation plans. They provide, among other things, information on the location and character of materials most suitable for final cover of the mined land. Guides for the analysis and interpretation of geological surveys for this purpose are beyond the scope of the present committee.1/ The discussion here concerns interpretations for soils in areas where surface mining is proposed.

1/ The following publications contain valuable guides for the analysis and interpretation of geologic information and references to other publications:

a. Mine Spoil Potentials for Water Quality and Controlled Erosion. Division of Plant Sciences, College of Agriculture and Forestry, West Virginia University, Morgantown. Environmental Protection Agency, Water Pollution Control Research Series; 14010 EJE; December 1971.

The Western Regional Conference considered a guide developed by the staff in North Dakota for assessing the suitability of soil materials as final cover for mined land. Of special concern is the thickness and extent of materials that are suitable for respreading on the surface of regraded areas to provide a medium for plant growth. The North Dakota guide is reproduced in Appendix E. The Western Regional Conference favored using the criteria for rating soils as a source of topsoil instead of adopting a new guide. The guide for rating soils as sources of topsoil is attached as Appendix F.

It has been pointed out to the present committee that the guide for rating the suitability of soils for topsoil16 of limited usefulness in many areas of Pennsylvania and adjacent states because it is too restrictive. Most of the materials available for final cover for mined land in such areas have poor suitability (the lowest rating) by the current criteria; yet there is a significant range in the suitability of those "poorly suited" soil materials. Thus for rating soils for final cover for mined land, guidelines for selecting the most suitable materials among those available locally would be useful.

It would seem feasible to revise the current guide for rating soils as a source of topsoil so that it could serve also for rating soils for use as final cover for mined land. For both objectives the primary consideration is providing a medium favorable for establishment and growth of adapted plants.

B. Interpretations of Soils Resulting from Mining Operations

The Western Regional Conference concluded that soils altered by mining operations can be interpreted using the guides already available, provided they are described and characterized adequately according to current standards and procedures used for natural soils.

It was mentioned earlier that the kinds of interpretations that can be made depend on the number, and the importance for the objective, of soil characteristics that are controlled in the mapping and classification of the soils. If the soils can be classified and mapped accurately as phases of soil families, current guidelines for making interpretations can be used until more experience data on soil behavior by classified kinds of soils are accumulated. Current procedures for using Form SCS-Soils-5 for correlation of interpretations should apply to soils in mine spoils as they do for natural soils.

(Continued)

b. Mine Spoil Potentials for Soil and Water Quality. R.M. Smith, et al, West Virginia University. Environmental Protection Agency, Environmental Protection Technology Series EPA-670/2-74-070. October 1974.

c. Lignite Mine Spoils in the Northern Great Plains--Characteristics and Potential for Reclamation. F.M. Sandoval, J.J. Bond, J.F. Power, and W.O. Willis. Research and Applied Technology Symposium on Mined Land Reclamation, Pittsburgh, Pennsylvania. March 1973

Several of the committee expressed the need for caution In making interpretations of soils in mine spoils--especially engineering interpretations. Soil permeability, for example, is thought to vary widely over short distances and within similar materials because of differences In compaction by heavy machinery during reclamation. Differences in moisture content at the time of final grading can result in large differences in degrees of compaction between otherwise similar soils. Consequently, predictions of behavior of soils in mine spoils should be conservative until we have more data on the behavior of classified soils.

Results of lnvestlgatlons that have been conducted in West Virginia, North Dakota, and other places on special problems encountered in mine spoils need to be assembled in a readily available form for guidance of soil scientists and others who must make interpretations for these soils. Among these are extreme acidity arising from sulfide minerals, potential acidity from sulfide minerals, field clues to the likely presence or absence of pyrite or other minerals that are unstable In oxidizing environments, and problems associated with high clay and high absorbed sodium content.

Recommendations

A. Classification of Soils on Mine Spoils

1. The definitions and criteria for the proposed suborder of Spolents should be studied further and revised before further consideration is given to incorporating the suborder into the soil classification system.
2. For the present, soils on mine spoils and other areas affected by mining operations should be classified at appropriate levels of the current classification system.
3. The feasibility of setting a limit between Orthents (or Spolents) and Arents at 20 percent by volume of fragments of diagnostic horizons in the 10 to 40 inch section should be tested.
4. The criteria for Fluvents and Fluventic subgroups should be amended to exclude soils in mlne spoils that have an irregular distribution of organic carbon with depth.
5. The possibility of making the lower limit in degree of expression of the camblc horizon slightly more restrictive, by requiring peds distinct enough that crushing them results in a perceptible change of color, should be tested.

B. Identification and Naming of Mapping Unlts

1. The categorical level at which soils on mine spoils are named and identified should depend on the objectives of the survey and on the resources available to make the survey.

2. Where identification of soils as phases of great groups will meet the objectives of the survey, cur-rent conventions-for-naming mapping units at that level should be followed. The inclusion of a short term in the name to indicate that the soil has been altered seems feasible.

3. Where identification of the soils as phases of families is required for the objectives of the survey, the short (common) names for soil families should be used in the names of mapping units.

4. We should be conservative in using soil series to name soils on mine spoils. It is proper to test the idea of mapping and classifying such soils at the series level. In those instances, however, the soils should be examined more systematically than would be necessary for natural soils in order to establish the validity of the series classification.

C. Interpretations

1. Guides for rating soil materials for use as final cover for mined land should be prepared.

2. Predictions of behavior of soils on mine spoils should be conservative until more data on the behavior of classified soils have been accumulated.

3. Results of investigations of special problems encountered in soils on mine spoils should be assembled for guidance in making interpretations. Among the special problems that should be included are extreme acidity arising from sulfide minerals, potential acidity, field clues to the presence or absence of sulfide minerals, and high clay and high absorbed sodium content.

Committee Members

Frank J. Carlisle, Jr., Chairman
R. M. Smith, Vice Chairman
O. W. Rice
J. A. DeMent
R. E. Nelson
T. J. Holder

L. D. Giese
R. I. Turner
E. J. Ciolkosz
G. A. Nielson
G. J. Post

J. B. Fehrenbacher
G. J. Latshaw
K. O. Schmude
R. L. Googins
W. M. Edwards

Except for a few changes in the Recommendations section that were suggested by the Conference, the foregoing part of this report is essentially like the draft preliminary report dated September 1974 that was sent in September to the committee members and in October to expected participants in the National Conference. Comments on the draft preliminary report that were received by the committee chairman before January 21 were included in the discussions by the discussion groups to the extent that was feasible.

Reactions of the Conference Discussion Groups

Notes on the reactions of the discussion groups of the conference to the preliminary committee report are presented in this section. The notes are arranged according to the outline of the preceding section on "Recommendations."

A.l. and A.2. Each of the discussion groups considered these statements and either explicitly agreed with them or did not express disagreement. Several people reacted favorably to the proposal that soils in mine spoils be kept together in a class at the suborder level, as in the proposal from West Virginia. However, a majority of those who expressed an opinion seemed to favor classifying the soils in the present suborders of Soil Taxonomy. One of the discussion groups suggested that the initiative for revising the proposal for Spolents so that it might apply more generally should be left with the authors of the proposal. A suggested alternative to the proposed suborder of Spolents was to bring soils in mine spoils together in extragrade subgroups of the appropriate greater groups.

A.3. Each of the discussion groups considered this statement. They agreed that a revised statement of the limit between Arents and Orthents (or Spolents) was needed and that the proposed limit should be tested. Discussion group B thought that the proposed 20 percent limit likely is too high.

A.4. Each of the discussion groups discussed this item and either agreed with the statement or did not object to it. Two groups (B and C) thought the proposal would not work because it would upset the present classification of Fluvents; i.e. many soils that clearly belong in Fluvents do lack evident stratification in the 10 to 40 inch section. They thought, however, that the proposed testing might result in a more useful proposal for solution of the problem posed by the Northeast Regional Committee.

In two of the discussion groups a question was raised whether the irregular distribution of organic carbon in the soils in mine spoils was due to relatively recent organic matter (i.e. Holocene Age) or if it represented fossil organic matter in carbonaceous rocks. (See Soil Taxonomy, Preliminary Abridged Text, Oct. 1973, pages 147 and 141.) This question could not be answered from the information at hand at the time. (Note: Subsequent references to published literature indicate that methods commonly used to measure organic matter in soils--the ignition method and the Walkley-Black wet oxidation method--do measure "fossil" organic carbon of carbonaceous rocks. (See "Mine Spoil Potentials for Soil and Water Quality," EPA-670/2-74-070, October 1974, pages 64 and 65.) Thus, analytical data showing irregular distribution of organic carbon with depth in soils in mine spoils may result, at least in part, from the measurement of fossil organic carbon from rocks. At the same time, it is clear from field evidence that some of the soils have irregular distribution with depth of organic carbon of Holocene Age. Perhaps the distinction between Orthents (Spolents) and Fluvents could be written to allow an irregular distribution of organic carbon with depth in Orthents (Spolents) provided that it is not associated with stratification of the soil materials.)

A.5. Three of the discussion groups considered the suggestion to test the proposal to make the definition of the cambic horizon slightly more restrictive by requiring peds distinct enough that crushing them results in a perceptible change of color. Reference here is to criterion 4.d. of the definition on page 33 of the preliminary abridged text of Soil Taxonomy dated October 1973. The three discussion groups agreed that the proposal warranted testing, but not without some dissent. Dr. Dudal pointed out that a decision to change the definition of the cambic horizon could change the classification of many soils that are not involved in the question of the distinction between soils in mine spoils and Fluvents. If such a change in definition were made, a review of all series having cambic horizons by the present definition would be required.

Two discussion groups considered how the tasting of proposals in Items A.3, A.4, and A.5, should be done. Group A suggested this should be referred to the Regional Soil Survey Conferences. Group D suggested that the principal soil correlators should be instructed to arrange for testing the proposals.

B.1, B.2, B.3, and B.4. These statements were considered only briefly by discussion groups A and B and were not discussed by the other two groups. Two people expressed opinions that these kinds of mapping units should be named as miscellaneous land types rather than for taxonomic classes. Beyond that, no objections to the statements were expressed.

C.l and C.3. Each of the discussion groups considered these statements. Groups B, C, and D were not satisfied with the proposals. In groups B and C It was pointed out that current guidelines for rating soils as sources of topsoil are not workable for rating soil materials as final cover for mined land. In group C it was suggested that the present guide for rating soil materials as topsoil be retained for the more limited use for which It. was intended and for which it works well. They suggested that a new guide should be prepared for rating materials as final cover for mined land. More than one guide may be useful because of the large difference in the nature of available materials and regional differences in environments.

Mr. Peters pointed out that a number of agencies and working groups are presently involved in making guidelines for reclamation of mine spoils, but there seems to be little coordination among them. He Indicated that general standards are lacking for the kind of information required for planning reclamation and for the methods used to acquire the necessary data. This results in much uncertainty and difficulty for agencies and groups that are involved in making contracts for obtaining information needed for planning reclamation.

Discussion group D suggested that the Deputy Administrator for Soil Survey take leadership in arranging for coordination of efforts of the National cooperative Soil Survey in tnis respect with other agencies and groups that may be working on similar guides. Groups mentioned specifically were the SEAM group of U.S.D.A., the Bureau of Reclamation, the Bureau of land Management, and the Environmental Protection Agency.

Two discussion groups emphasized that planning reclamation of mine spoils requires evaluation of all materials in the overburden as to their suitability as final cover for the mined land. The soil survey has a unique input for evaluation of the uppermost several feet of the overburden. Evaluation of materials below that depth requires a joint effort of geologists and soil scientists.

Discussion of the Committee Report by the Conference

In reference to items A.1. and A.2., Dr. Bartelli indicated that a committee of the 1967 National Soil Survey Conference had dealt with the classification and naming of highly disturbed soils. In the discussion that followed, a question was raised whether the scope of the committee should be broadened to include all highly disturbed soils, such as those resulting from the cutting and filling of land shaping operations. Reactions to the question were mixed. (Note: Committees of the 1965, 1967, 1969, and 1971 National Soil Survey Conferences dealt with Made land and shaped or disturbed soils.)

It was suggested that recommendations A.3., A.4., and A.5., be referred to committees of the four Regional Soil Survey Conferences. With respect to A.4. it was stated again that many Fluvents lack stratification, so there is no need to test the recommendation as stated in the draft committee report. On the other hand, the criteria for Fluvents and Fluventic subgroups still need to be amended to exclude soils in mine spoils that have irregular distribution of organic carbon with depth, and that question could be referred to the Regional Conferences.

With respect to item A.5., Bartelli and Coover indicated that the definitions of soil structure and of soil fragments in Chapter 5 of the revised Soil Survey Manual should resolve the question to which this recommendation of the committee was addressed. Rourke indicated that the recommendation of the Northeast Conference was concerned with the distinction between Fluvents and Fluventic subgroups based on the definition of the cambic horizon. In the discussion that followed, several other people expressed reservations about the advisability of changing the definition of the cambic horizon.

Rourke commented that the West Virginia proposal to use short, location-related names to identify families of soils in mine spoils was not identical to the common (short) family names provided for in Soil Taxonomy because the names were not series names. In the discussion it was suggested that, according to present rules. a series could be defined for a family and that series name could then be used as the short family name.

Grossman commented that most of the committee report had been concerned with classification of the soils involved. He suggested that more emphasis should be placed on characterizing the soils.

The Conference suggested that this committee should be continued and that the regional conferences should have parallel committees. Mr. Johnson suggested that the name should be changed to "Soils and Soil Materials Disturbed by Mining Operations, Their Characteristics, Classification, and Interpretations."

The committee chairman was instructed to change the "Recommendations" section of the preliminary draft report so that the statements are in the form of recommendations. That has been done.

F.J.C.

APPENDIX A

Proposed Classification, Mapping, Use and Management of Minesoils

Prior to the development of the new comprehensive soil classification system by the National Cooperative Soil Survey, Minespoil was not considered to be soil. It was identified in mapping legends as a miscellaneous land type and was delineated and named as "Strip Mine." Mine Spoil was not examined and studied in the detail required to enable one to make meaningful statements in regards to its use and management.

In the new soil classification system, Soil Taxonomy, Soil Conservation Service, U.S.D.A., soil is defined as "the collection of natural bodies on the earth's surface, in places modified or even made by man of earthy materials containing living matter and supporting or capable of supporting plants out-of-doors." In this system, soils are classified on the basis of characteristics which can be observed or measured in the field and in the laboratory. The system is hierarchical and from the highest category to the lowest is comprised of: Orders, Suborders, Great Croups, Subgroups, Families. and Series.

The comprehensive system is broad and flexible enough to permit the definition of categories as necessary to accomodate diverse mine-soils and to further their scientific study as well as their effective use and management. We suggested previously (West Virginia University, 1971) that spoils and coal wastes from mining can be studied and classified on the basis of soil profile properties, the same as other soils and can then be incorporated into the comprehensive system of soil classification. This does not mean that categories have already been formally defined that are adequate to include all mine-soils.

In our proposal, minesoils would be classified at the Order level as Entisols. Entisols are recent soils that have little or no evidence of development of pedogenic horizons.

Presently. there are five Suborders in the Order of Entisols. These are as follows:

(a) **Aquents** - soils which. if they are not artificially drained are uet most of the year;

(b) **Arents** - soils which have fragments of diagnostic horizons;

(c) **Psamments** - soils which are sandy;

(d) **Fluvents** - soils which have formed in recent water deposited sediments; and

(e) Orthents - soils which occur on recent erosional surfaces.

We are of the opinion that none of these suborders would adequately accommodate minesoils. In our proposal, a new suborder, <u>Spolents</u>, would be established for minesoils, which might include certain other man made soils as well. The proposed classification scheme is as follows:

<u>Suborder Spolents</u> - These soils include recently deposited earth materials resulting from surface mining or other earth moving operations, or deposits of solid wastes accumulated in connection with some phase of mining or other industrial activity or deposits from such activities as sanitary landfills. These soils have the properties of Entisols, and they have characteristics 1, 2 and 4 of the Orthents but may or may not have characteristic 3. In addition they must have at least 3 of the properties listed below. In many cases pedons will exhibit more than 3, and polypedons encompassing several square meters will exhibit all or nearly all of the 6 properties identified.

1. If coarse fragments constitute at least 10% of rhc volume of the control section, they arc disordered such that more than 50% will have their long axis at an angle of at least 10% relative to any plane in the profile. The test for disorder should exclude fragments with longest diameter less than 3/4 inch (2 cm.) or greater than 10 inches (25 cm.) and should bc based on numbers of coarse fragments rather than volume.

2. Color mottling without regard to depth or spacing in the profile. The mottling involves color differences of at least two color chips in the standard Munsell soil color charts. This mottling occurs among fines as well as within coarse fragments or between fines and coarse fragments.

3. If coarse fragments are fissle, the edges are frayed or splintcry rather than smooth.

4. coarse fragments bridging across voids as a result of placement of materials, leaving discontinuous irregular pores larger than texture porosity. Such voids are present consistently but vary in frequency, prominence, and size.

5. A thin surface horizon or horizon immediately below a surface pavement of coarse fragments, which contains a higher percentage of fines (less than 2mm.) than any other horizon in the profile to the bottom of the control section. This horizon ranges from 1 to 4 inches (2.5 to 10cm.) thick in most minesoils, but it may be thicker in minesoils that have been "topsoiled".

6. Local pockets of materials, excluding single coarse fragments, that range from 3 inches (7.6 cm.) to 40 inches (100 cm.) in horizontal diameter. These pockets have no lateral continuity and are the result of the original placement of materials and not postdepositional processes. They may differ from the surrounding material in color (2 or more Munsell color chips), soil textural or particle size class; or dominant rock type constituting the coarse fragments.

Great Group - Udspolents - Spolents in the udic or humid moisture regime.

Subgroups -

1. Fissle Udspolents - Udspolents where at least 65% of the total coarse fragments within the control section are shales with bedding planes evident at spacings of 2mm. or less.

2. Plattic Udspolents - Udspolents where at least 65% of the coarse fragments within the control section are thick bedded sandstones with grain sire greater than 0.05 mm.

3. Regolithic Plattic Udspolents - Plattic Udspolcnts in which 90% or more of the sandstone coarse fragments have interior chroma greater than 2.

4. Carbolithic Udspolents - Udspolenta in which greater than 50% of the coarse fragments within the control section have a Munsell soil color value of three or less for the streak or the powder of the coarse fragmenta. This includes coal, bone coal, and carbon rich shales and muds.

5. Typic Udspolents - Udspolents that are not dominated by any one rock type within the control section, and does not qualify for any other subgroup.

6. Several subgroups in addition to the ones listed msy be needed. For minesoils with less than 10% coarse fragments, it would seem that a subgroup Matric Udspolents might be appropriate. For minesoils that have a high percentage of limestone or other calcareous materials, Kalkig Udspolents might be suggested. Lithic could be used as an additional modifier for any other subgroup in which the depth to bedrock is less than 20 inches (50 cm). No mappable expanse of these suggested subgroups has been found in West Virginia to date, but it is likely that such will be found in other regions.

Family

1. Particle Size - The particle size of W. Va. minesoils is dominantly loamy-skeletal with a few sandy-skeletal and clayey-skeletal. However, non-skeletal minesoils are known to occur.

2. Mineralogy - The mineralogy of minesoils is assumed to be siliceous for the Plattic and Regolithic Plattic Udspolents and mixed for the other subgroups until proven otherwise. New mineraology classes are likely to be needed for the Carbolithic Udspolents because of the dominance of coal and other high carbon fragments.

3. Reaction -
   A. Extremely acid - pH < 4.0
   B. Acid - pH 4.0 - 5.5, inclusive
   C. Neutral - pH 5.6 - 8.0, Inclusive
   D. Alkaline - pH > 8.0

4. Soil Temperature Class - Mesic in West Virginia. Other classes probably occur as defined for other soils.

Suggested Minesoil Families That May Occur as Mappable Units in West Virginia

1. Regolithic Plattic Udspolents; sandy-skeletal, siliceous, acid; mesic. Name: Cuzzart family-(May be loamy-skeletal).

2. Plattic Udspolents; sandy-skeletal, siliceous, extremely acid, mesic. Name: not assigned (May be loamy-skeletal).

3. **Plattic** Udspolents; sandy-skeletal, siliceous, acid, **mesic. Name:** Birdcreek family (May be **loamy-** skeletal).

4. Pissile Udspolents; loamy-skeletal, mixed, extremely acid, mesic. Name: **Albright** family (May be acid and not extremely acid).

5. Pissile Udspolents; clayey-skeletal, mixed, neutral, mesic. Name Bridgeport family

6. Fissile Udspolents; loamy-skeletal, mixed, acid, mesic. Name: Brandonville family.

7. Carbolithic Udspolents; loamy-skeletal, mixed, extremely acid, mesic. Name: Century family.

8. Carbolithic Udspolents; loamy-skeletal, mixed, neutral, mesic. Name: not assigned.

9. Carbolithic Udspolents; loamy-skeletal, mixed, acid, **mesic. Name**: not assigned.

10. Typic Udspolents; loamy-skeletal, mixed, extremely acid, mesic. Name: not assigned (Play not occur in West Virginia as a mappable unit).

11. Typic Udspolents; loamy-skeletal, mixed, acid, nesic. Name: Canyon family.

12. Typic Udspolents; clayey-skeletal, mixed, neutral, mesic. Name: not assigned (May be loamy-skeletal).

13. Schlickig Udspolents; fine-loamy, mixed, neutral, mesic. Name: Mark Twain family **(Mo.)** (May occur also in West Virginia where **calcareous,** non-fissle (Schlickstone) **mudrocks** are abundant).

14. Regolithic Fissile Udspolents; loamy-skeletal, mixed, acid, mesic. Name: not assigned.

Note that these'tentative names may not all occur in West Virginia in mappable units. It is estimated that 10 soil family names may cover the mappable units that are important in the State.

All characteristics for classification of **minesoils** would be determined within a control section of 10 to 40 inches (25 to

100 cm.) from the surface. Present evidence indicates that pH at the top of the control section, i.e. at 10 inches (25 cm.) would probably be a satisfactory indication for family definition. This has been true in profile studies to date, which however, have not included very many profiles in carbolithic or coaly minesoils. In such cases, however, it is considered that extreme acidity, the major concern in carbolithic minesoils, would' be unlikely unless the pli at 10 inches was below 4.0. This is expected because of the dependence of rapid pyritic oxidation on high oxygen concentrations and on thiobacillas micro-organisms that are inactive at pH levels above 5.5 and at low oxygen concentrations. Thus, even if we should define the acid categories of soil families in terms of the dominant pH within the control section, we are suggesting that pH at 10 inches (25 cm.) is likely to be a generally satisfactory criterium for pH status of the entire control section.

Minesoils could be classified at the Series level, the lowest category in the system, by defining all other significant soil profile properties. such as details of texture, color, mottling, structure, horizons, and pocket inclusions. Since some of these properties, however, are changing rapidly in young minesoils it is judged satisfactory, at present, to delay classificationat the series level until the rate of change of minor properties has become relatively slow, or at least 10 years following establishment of vegetation. Such delay does not appear necessary however, for useful classification and mapping at the family level. Names such as Cuzzart, Canyon , etc, have been given to the families. One justification for this, is that simple names can be given to soil mapping units.

It might be desirable to map phases of certain soil families in order to satisfy specific practical needs. For example, steep slope and extremely stony phases would apply to some outslopes in steep terrain. However, the outslopes might be indicated more satisfactorily in mapping by an appropriate elongate symbol rather than an enclosed area. Other useful phases might be: (1) extremely acid surface phase; (2) weathered topsoil phase; (3) alkaline geologic topsoil phase; and (4) rough surface phase (where use of farm machinery would not be feasible).

Soil testing to determine lime and fertilizer needs for intensive uses would be necessary in addition to the best of classification and mapping. Also, full descriptions of such features as gullies, ponded water, large surface atones, and inclusions of distinctly different minesoils would be a part of the definitions of minesoil mapping units.

Management and land use implications by families are imperfectly tested at present, but several generalizations seem likely to apply. With extremely acid families, for example, covering with at least six inches of favorable material, probably would be a standard recommendation, whereas with acid families liming would be feasible for forage seedings; and with neutral families no liming would be needed.

From the standpoint of available soil water and fertility, the sandy skeletal, siliceous families would be generally unfavorable for forage production, but would be favorable for roadways, camping, and certain specialty crops. On the other hand, clayey-skeletal and schlickig, neutral families would be most productive as meadowlands, but would lack stability for roadways or stability on steep slopes.

0

Summary

The strip mine areas in Warrick County appear to fit into mapping units which coincide in characteristics to those units set forth in Indiana Surface Mine-Reclamation law. Prom our observations the following units will satisfactorily characterize these areas,

(a) Orthents, clayey skeletal, 0 to 8 percent slopes. This unit includes land graded for Row crop (tillable land). All exposed rocks, stones end boulders larger than six inches in diameter have been buried or removed (rocks does not apply to the shales that disintegrate in less than 3 years). Reaction is dominately pH 5.5 to neutral. There will be some inclusiona of acid spots. Fits the category of Row crop land as described in Indiana lau.

(b) Orthents, clayey skeletal, 8 to 25 percent slopes. All rocks, atones and boulders larger than 6 inches in diameter have been buried where practical with a minimum cover of 6 inches of soil. (Rock left on surface does not apply to rocks that will disintegrate in less than 3 gears). This unit fits the requirement eatabliehed for pasture and hay land in Indiana law. Reaction is dominately pH 5.5 to neutral. There will be some inclusions of acid spots.

(c) Orthenta, clayey skeletal. 8 to 33 percent slopes (graded for Forest Land or Range Laud as specified by State law). Some stones and boulders are on the surface. Conditions are such that it would be difficult to use normal type farm machinery for seeding and seed bed preparation. Reaction is dominately pH 5.5 to neutral. There will be some inclusions of acid spots.

(d) Orthents, clayey skeletal, 33 to 90 percent slopes. Ungraded areas ● tripped prior to recent enactment of Indiana laws requiring grading. Dominately vegetated to timber. Reaction dominately pH 5.5 to neutral with some inclusions of acid spots. Pew boulders and ● tone but rock is mostly of the type that disintegrated vhen exposed on the surface after about 3 years.

(e) Orthents, clayey skeletal, 33 to 90 percent slopes, stony phase. Ungraded areas stripped prior to recent enactment of Indiana laws requiring grading. Similar to (d) except that there are many atones and boulders on the surface (dominately massive sandstones that weather slowly). Reaction ranger from extremely acid to neutral and has this wide range within ahort distances. Additional inform&ion will be gathered on reaction.

Belmont County, Ohio

Strip Mine Spoils - Approved legend - Initial Field Review - 10-27-72

TAd Typic Udorthents, fine-loamy, mixod, acid, mesic
Acid, shaly silty clay loam spoils
(Strip mine field study Stops 2 and 9)

Units:
TAdB Acid shaly silty clay loam spoils, 0 to 8 percent slopes
TAdD Acid shaly silty clay loam spoils, 8 to 25 percent slopes

TCe Typic Udorthents, loamy-skeletal, mixed (calcareous), mesic
Calcareous stony clay loam spoils
(Strip mine field study Stop 4)

Units:
TCeB Calcareous stony clay loam spoils, 0 to 8 percent slopes
TCeD Calcareous stony clay loam spoils, 8 to 25 percent slopes
TCeE Calcareous stony clay loam spoils, 25 to 40 percent slopes
TCeF Calcareous very stony and boundery clay loam spoils, 25 to 70 percent slopes

TCg Typic Udorthents, clayey-skeletal, mixed (calcareous), mesic
Calcareous stony clay spoils
(Stip mine field study Stops 1 and 10)

Units:
TCgB Calcareous stony clay spoils, 0 to 8 percent slopes
TCgD Calcareous stony clay spoils, 8 to 25 percent slopes
TCgE Calcareous stony clay spoils, 25 to 40 percent slopes

TEC Typic Udorthents, loamy-skeletal, mixed, extremely acid, mesic
Extremely acid stony sandy loam spoils
(Strip mine field study Stops 5 and, 6)

Units:
TEcB Extremely acid stony sandy loam spoils, 0 to 8 percent slop66
TEcD Extremely acid stony sandy loam spoils, 8 to 25 percent slope6
TEcE Extremely acid stony sandy loam spoils, 25 to 40 percent slopes
TEcF Extremely acid very stony and bouldery sandy loam spoils, 25 to 70 percent slopes .

TEe Typic Udorthents, loamy-skeletal, mixed, extremely acid, mesic
Extremely acid stony loam and clay loam spoils
(Strip mine field study Stop 7)

Units:
TEeB Extremely acid stony loam and clay loam spoils,
0 to 8 percent slopes

TNe Typic Udorthent, loamy-skeletal, mixed, nonacid, mesic
Nonacid stony clay loam spoils
(Strip mine field study Stop 3)

Units:
TNeB Nonacid stony clay loam spoils, 0 to 8 percent slopes
TNeD Nonacid stony clay loam spoils, 8 to 25 percent slopes

Explanation of Symbols

First letter
T - Strip mine spoils

Second letter
A - Acid spoils - pH range 3.6 to 5.5
c - Calcareous spoils
E - Extremely acid spoils - pH less than 3.6
N - Nonacid spoils - pH range 5.6 to 7.3

Third letter - texture control section
a - sandy
b - coarse-loamy
c - loamy-skeletal, sandy loams
d - fine-loamy
e - loamy-skeletal, loams and Clay loam6
f - fine
9 - clayey-skeletal

Fourth letter - slope range
B - 0 to 8 percent sloper
D - 8 to 25 percent slopes
E - 25 to 40 percent slopes
F - 25 to 70 percent slope6

Established Series
Rev. ECN:RCB:JWF
1/72

KANIMA SERIES

Th. Kanima 'art.' I' . member of the loamy-skeletal, mixed, nonacid, thermic family of Udalfic Arents. Those rolls have very d.rk grayish brown shaly rllty clay loam A horizons and very dark grayish brown very shaly rllty clay loam C horizons containing fragments of argillic horizons.

Typifying Pedon: Kanima shaly silty clay loam.
(Colors are for moist soil unless otherwise stated.)

Ap -- 0-6" -- Very d.rk grayish brown (2.5Y 3/2) shaly silty clay loam; massive; friable; 20 percent shale fragments; I percent coal fragments; neutral; diffuse wavy boundary. (4 to 12 inches thick)

C -- 6-72" -- Very d.rk grayish brown (2.5Y 3/2) very shaly rllty clay loam; massive; friable; 70 percent very d.rk gray (N/3) shale fragments In the upper part and 85 percent shale fragments In th. lower part; few fragments of very d.rk grayish brown (10YR 3/2) granular silt loam and yellowish brown (10YR 5/4) silty clay loam having thin patchy clay films; 2 percent coal fragments; neutral.

Type Location: Haskell County, Oklahoma; about 3 miles south of Tamaha, 2.100 feet south and 1300 feet west of th. northeast corner of rec. 8, T. IO N., R. 22 E.

Range in Characteristics: All *horizons are very shaly clay loam, shaly clay loam, very shaly* loam, shaly loam, very shaly silty clay loam, shaly silty clay loam, very shaly silt loam, or shaly silt loam. They are medium acid through moderately alkaline. Coal fragments range fra . trace to 5 percent. The A horizon is d.rk grayish brown (10YR 4/2; 2.5Y 4/2), very d.rk grayish brown (10YR 3/2; 2.5Y 3/2), or dark brown (10YR 4/3). It is massive and h.rd or very h.rd when dry. Where the A horizon has values of 3. the C horizon has values of 3 or less. Rock fragments less than 3 Inches In diameter In the A horizon range from about I5 to 90 percent by volume and typically are I5 to 50 percent. Rock fragments more than 3 Inches In diameter range from 0 to 5 percent by volume. The C horizon Is very dark grayish brown (2.5Y 3/2; 10YR 3/2), d.rk grayish brown (10YR 4/2; 2.5Y 4/2), olive brown (2.5Y 4/4), grayish brown (10YR 5/2), or brown (10YR 4/3, 5/3) with fragments or pockets of soil having colors of higher chroma. Rock fragments la's than 3 Inches In diameter In the C horizon range from about 35 to 95 percent by volume and typically are 60 to 90 percent. Rock fragments more than 3 Inches In diameter range fra 5 to 30 percent by volume. Rock fragments are In shades of gray, brown, yellow, or white. The C horizon contains pockets or fragments of argillic horizons similiar to those of the associated Alfisols.

Competing Series and their Differentiae: These are Ceda, Demopolis, and Eddy series. Ced. soils have siliceous mineralogy and irregular distribution of organic matter. Demopolis rolls have carbonatic mineralogy and are shallow. Eddy soils are drier for longer lengths of time, and have carbonatic mineralogy. Non. has fragments of argillic horizons.

Setting: Kanima rolls are gently sloping to very steep uplands. They consist of dumps that *remain after strip mining operations.* Slope *gradients are* 3 *to 50 percent. The climate* Is warm and humid. These soils are formed In material weathered from shale, sandstone,and limestone. At the type location the average annual precipitation Is 42 Inch.', the mean annual temperature I' 62° F., and the Thornthwaite P-E Index Is 71.

Principal Associated Soils: These are th. Dennis, Liberal, Okemah, Stigler, Tamaha, and Vian soils. Dennis and Okemah roll' have mollic epipedons and B2t horizons. Liberal, Stigler, Tamaha, and Vian soils have B2t horizons.

Drainage and Permeability: Well drained; runoff Is slow through rapid, depending on amount of compaction, age, or amount of weathering and slop.; permeability Is moderate or moderately rapid, depending on percent of coarse fragments.

Use and Vegetation: Used mainly for wildlife habitat, recreation, and landfills. Vegetation of th. older spoil banks Is elm, hackberry, sycamore, cottonwood, sumac, and black locust trees with . sparse to moderate understory of grasses, weeds, and legumes.

Kanima Series

Distribution and Extent: Eastern Oklahoma and other States that have strip mining operations. The series is of moderate extent.

Series Established: Haskell County, Oklahoma; 1972.

Remarks: These soils were formerly classified as a land type named "Mine pits and dumps". These soils are the spoil banks that were formed as the result of strip mining. The strip mines were worked with equipment such as bulldozers and drag lines.

National Cooperative Soil Survey
U. S. A.

Approved by Principal Soil Correlator
STSC, 1/24/74
Lu D Nichols

Est
~~Tentative~~ Series
Rev. CDB:FLG
8/73

PALMERDALE SERIES

The Palmerdale series Is a member of the loamy-skeletal. mlxed, acid. thermlc famlly of Tvplc Udorthents. Typically, these soils have dark grayish brown very shaly silt loam A end C horlzons.

Typlfvlng Pedon: Palmerdale very shalv silt loam - Idle.
(Colors are for moist soll unless otherwise stated.)

Ap -- 0-5" -- Dark grayish brown (2.5Y 4/2) very shalv silt loam; weak medium granular structure; friable; approximately 80 percent randomly oriented coarse fragments, mostly fissle shale with some broken sandstone and coal; very strongly acid; abrupt smooth boundary. (0 to 7 inches thick)

C -- 5-80" -- Dark grayish brown (2.5Y 4/2) very shaly silt loam; massive; friable; approximately 85 percent randomly orlented coarse fragments, mostly flssle shale with some broken sandstone and coal; few Irregularly shaped voids, associated with coarse fragments: very strongly acid. (70 inches to many feet thick)

Type Location: Blount County, Alabama. NE1/4NE1/4sec. 3, T. 14 S., R. 2 W.

Range In Characteristics: Thickness of the shaly mine spoil materlal is greater then 5 feet. Reaction Is extremely to strongly acid. The coarse fragment content ranges from 40 to 90 percent In the A horizon and from 60 to 90 percent In the C horizon. Coarse fragments of shale are mostly 1/2 Inch to 5 Inches along their longest axis and many are easily broken under moderate pressure. The A horizon Is dominantly dark gray (5Y 4/1), dark grayish brown (IDVR 4/2; 2.5Y 4/2), brown (IDVR 4/3, 5/3), dark yellowlsh brown (10YR 4/4), and yellowlsh brown (IOVR 5/6). Other colors are permitted In the series. The fine fraction is loam, silt loam, or silty clay loan. The C horlzon Is ollve (5Y 4/3, 4/4, 5/3, 5/4, 5/6), dark grayish brown (2.5Y 4/2), derk yellowlsh brown (IOVR 4/4), brown (IDVR 5/3), yellowlsh brown (IDVR 5/4, 5/6), or dark brown (7.5YR 4/4), and mottles In these colors are common. Textures of the flne earth fractlon In the C horizon are loam, silt loam, or silty clay loam.

Competing Series and their Differentiae: There are no other members of this family.

Setting: Palmerdale soils are on nearly level to very steep slopes. They make up the majority of mine spoil areas where coal mining operations have taken place. Slope gradients range from 2 to 60 percent, depending on whether the spoils have been smooth or how thev were stocked. Where smoothed, slopes are gentle and fairly uniform over large tracts. Near the type locatlon the mean annual temperature Is 62° f.. and the average annual precipitation Is 54 Inches.

Principal Associated Soils: These are mostly In the Montevallo and Townley Series. These soils have consolidated rock et shallow depths and have B horlzons.

Drainage and Permeability: Somewhat excessively drained; medium runoff; moderately rapid permeability.

Palmerdale Series

"se and Vegetation: Many areas are Idle. Pine has been planted on some areas. Smoothed area, have mostly been planted to grasses for pasture and hay.

Distribution and Extent: Northern Alabama, Georgia, and Tennessee. The series Is of moderate extent.

Series ~~Proposed~~ Est.: Blount County. Alabama; ~~1973.~~ 1974 The name is from a village In that county.

Remarks: In Alabama. the Palmerdale soils have been classified as a land type In previous soil surveys. Host very new stripmine spoil material has voids between shale fragments. more nearly fitting the concept of the fragmental textural family. These materials soon compact.

National Cooperative Soil Survey

U. S. A.

SOIL INTERPRETATIONS FOR STRIP MINED LAND

Basic soils information is essential in obtaining satisfactory reclamation and restoration of lands disturbed by surface mines. Soil interpretations used in conjunction with the soil maps can indicate to planners, engineers and others the advisability of selecting, stockpiling and using specific soils as final cover for mined land.

Soil characteristics and interpretations significant to their use as final cover for mined land are given in the attached table. Soil characteristics or properties are estimated for representative soil profiles. These estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other areas. The interpretations are based on the soil properties and on the experience of soil scientists, agronomists and engineers with these soils. Following are explanations of some of the columns.

Parent Material: The disintegrated and partly weathered rock from which soil "as formed.

Natural Soil Drainage: Drainage that existed during the development of the soil as opposed to altered drainage or irrigation. Soil drainage as a condition of the soil refers to the frequency and duration of periods when the soil is free of saturation or partial saturation. Such conditions can be accurately measured, although the field scientist estimates them by inference. For class definitions, see Soil Survey Manual, pp. 169 to 172.

Depth of Rooting Zone: The depth of soil material that plant roots can penetrate readily to obtain water and plant nutrients. It is the depth to a layer that differs sufficiently from the overlying material in physical or chemical properties to prevent or seriously retard the growth of roots.

Available Water Capacity: The ability of soils to hold water for use by most plants. It is commonly defined es the difference between the amount of water in the soil st field capacity and the amount at the wilting point of most crops. The classes in the table are for a 60-inch soil profile snd are as follows: very low - 0 to 3 inches; Low - 3 to 6 Inches; Moderate - 6 to 9 inches; High - 9 to 12 inches; Very high - more than 12 inches.

Permeability: That quality of a soil thst enables it to transmit water or air. It is estimated on the basis of the soil characteristics observed in the field, particularly structure and porosity, and on the results of permeability and infiltration tests on undisturbed cores of similar soil materiel. The estimates do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Erodibility: Susceptibility to erosion. Estimates based on the following criteria:

Low - All roils in subclass IIe, level soils not subject to wind erosion, soils in class V and soils in s or w subclasses with erosion hazard comparable to that of subclass IIe soils.

Medium - All soils in subclass IIIe and soils in w or s subclasses with an erosion hazard comparable to that of subclass IIIe soils.

High - All soils except those that are coarse textured (Ifs, ls, etc.) in subclass IVe and soils in s subclasses with a comparable erosion hazard.

very High - All soils in VIe, VIIe, coarse textured soils in IVe, and soils in s subclasses with a comparable erosion hazard.

Where wind erosion is a hazard, it is specifically mentioned, e.g., severe wind erosion.

Inherent Fertility: Natural fertility of the soil based on the following criteria:

Low - Soils low in available P or K, or with pH below 5.0 in the A and upper B horizons, or soils having levels of salinity or alkalinity such that choice of plants or growth of plants is severely limited.

Medium - Soils intermediate between low and high in inherent fertility.

High - Soils high in available P and K, with pH of 5.5 or more in A and upper B horizons; levels of salinity or alkalinity are sufficiently low that choices or growth of plants are not limited.

Where salinity or alkalinity is a limitation, it is mentioned in this column.

Estimated Yields: Estimated yields under high level of management for commonly grown dryland crops.. These estimates are based on information obtained from farmers and other agricultural workers in the area. They are averages for a period long enough to include years of both favorable and unfavorable temperatures and moisture supply during the growing season.

Degree of Limitation for and Soil Features Affecting Final Cover for Mined Land: The ratings in these columns indicate the thickness and general suitability of soil materials that might be used as final cover for areas of mined land. The total thickness available, in inches, including that from A, B or C horizons is given in the first column. Relative suitability is shown in the second column. Only material that can serve as medium for plant growth is indicated and it is assumed that this material will be stockpiled and spread over leveled mine spoil.

Soil material given the rating good has physical, chemical and biological characteristics favorable for growth of vegetation. Suitability is affected mainly by ease of working and spreading the soil material, as in preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and content of stone fragments are characteristics that also affect suitability. In the following table, each of these characteristics is rated as to degree of limitation affecting use. The soil property giving the highest degree of limitation is used to rate the soil material as good, fair or poor.

Suitability Ratings of Soil Material for Use
as Final Cover for Areas of Mined Land

Items Affecting Use	Degree of Soil Suitability		
	Good	Fair	Poor
Moist consistence	Very friable, friable	Loose, firm	Very firm, extremely firm
Texture	fsl, vfsl, 1, sil, sl	cl, scl, sicl	s, lfs, ls, c, sic
Coarse fragments: percent, by volume	Less than 3%	3 to 15%	More than 15%
sodium content	Not class determining if less than 15% exchangeable sodium		More than 15% exchangeable sodium is unsuitable
soluble salts: conductivity of saturation extract	Less than 4 mmhos/cm	4 to 8 mmhos/cm	More than 8 mmhos/cm
Stoniness class 1/	0	1	2, 3, 4, & 5
Inherent fertility	High and medium	Medium	Low
Lime content	Low	Medium	High

1/ For class definitions, see Soil Survey Manual, pp. 216 to 223.

SOIL CHARACTERISTICS AND INTERPRETATIONS

Map Symbol	Soil Name	Land Cap. Sub-Class	Parent Material	Natural Soil Drainage Class 1/	Depth of Rooting Zone	Available Water Capacity	Permeability (Least perm. layer	Erodibility	Inherent Fertility *	Est. Yields (high management) Crops (dryland) Spring wheat bu/ac	Barley bu/ac	Oats bu/ac	Native Grazable Resources pdf/ac.	Degree of Limitation for and Soil Features Affecting Final Cover for Mined Land: Depth	Suitability
32A	Parshall fine sandy loam, 0 to 3% slopes	IIIe	Fine sandy loam alluvium	Well drained	60"	Mod	Mod. rapid	Medium	Medium	22	37	44	2150	0-37 37-60	Good Fair--medium lime
36B	Lihen loamy fine sand, 3 to 6% slopes	IVe	Sandy	Well drained	60"	Low	Rapid	Very high--severe wind erosion	Low	12	20	24	2200	60	Poor--sandy and mod. lime

1/ For class definitions, see Soil Survey Manual, pp. 169-172

FROM: Guide for Interpreting Engineering Uses of Soils. SCS 1/21/72

Column 10.--Topsoil. The suitability ratings in this column are intended for use by engineers, landacapets, nurserymen, planners, and others who make decisions about selecting, stockpiling, and using topsoil. The decision to stockpile surface soil at a construction site should depend on the quality of the topsoil and on the relative availability of other suitable topsoil in the immediate vicinity. The ratings in this column used in conjunction with the soil maps can indicate to engineers and others the advisability of selecting, stockpiling, and using a specific soil as topsoil.

The term "topsoil" has several meanings, but in soil survey interpretation the term describes soil material used to cover barren surfaces--generally made barren by construction--so as to improve soil conditions for re-establishment and maintenance of adapted vegetation and also soil material used to improve soil conditions on lawns and in flowerbeds and gardens where vegetation already may exist.

A soil given the rating of good as a source of topsoil has physical, chemical, and biological characteristics favorable to retablishmont and growth of adapted plants: it is friable and easy to handle and spread. Although a high content of plant nutrients in good balance is desirable in topsoil, of mote importance is responsiveness to fertilization and to liming, too, if pH adjustment is needed.

A soil that qualifies as a good source of topsoil not only must have upper layers that have the favorable characteristics requited for a rating of good or fair but is one in which the characteristics also ate such that the remaining soil material is reclaimable after the uppermost soil is stripped away. Some damage to the borrow area is expected, but if the damage is great enough for tevegetation and erosion control to become major problems, then the soil should be given a rating of poor as a source of topsoil--regardless of the characteristics of the surface materials. This constraint in evaluation does not apply to construction sites vhete soils ate drastically disturbed in the construction processes; the ratings of soils in such places as a source of topsoil may be different. Unless otherwise specified, however, it is assumed that sites from which topsoil is taken ate to be restored.

Also considered in rating soils as a source of topsoil ate features that determine the ease ot difficulty of excavating, particularly soil slope, wetness, and thickness of the suitable material.

Generally. only the surface layer is given a rating for this use; but if that layer is less than about 8 inches thick, assume that it will be mixed with the adjacent layer to make up a thickness of at least 8 inches, then give a rating to the mixture. If the subsoil is better suited than the surface layer, give a second rating and indicate that It is for the subsoil between depths of 8 and 30 inches or whatever depth limits apply.

Use Guide Sheet 13 for general guidance in determining the suitability ratings of soils as a source of topsoil. Some soil characteristics that affect suitability for this use, however, are not included in Guide Sheet 13. The following paragraph discusses some of those characteristics.

If a soil contains toxic substances, it should be given a rating of poor, as should a soil that contains sulfides--which in themselves might not be toxic but which induce a very low pH upon aeration. If a soil has rock outcrops that are so spaced and arranged as to make excavation difficult or impractical, this soil also should be given a rating of poor even though the soil between the outcrops is satisfactory as a source of topsoil. Soils for which true texture cannot be determined with confidence, such as Andepts, should be given ratings through comparison of their relative suitability with that of soils for which ratings have been determined by using Guide Sheet 13.

Guide Sheet 13.--Suitability ratings of soils es sources of topsoil

Item affecting use	Degree of soil suitability		
	Good	Fair	Poor
Moist consistence	Very friable, friable	Loose, firm	Very firm, extremely firm
Texture	fsl, vfsl, 1, ail; sl; sc if 1:1 clay is dominant	cl, scl; sicl; sc if 2:1 clay is dominant; c and sic if 1:1 clay is dominant	s, ls; c and sic if 2:1 clay is dominant
Thickness of material (generally uppermost part of profile)	More than 16 in	g-16 in.	Less than 8 in.
Coarse fragments: percent, by volume	Less than 3 pet	3-15 pct	More than 15 pct
Soluble salts: conductivity of saturation extract	Less than 4 mmhos/cm	4-8 mmhos/cm	More than 8 mmhos/cm
Stoniness class 1/	0	1	2. 3, 4, and 5
Slope	Less than 8 pct	8-15 pct	More than 15 pct
Soil drainage class 2/	Drainage class not determining if better than poorly drained		Poorly drained, very poorly drained

1/ For class definitions see Soil Survey Manual, pp. 216-223.

2/ For class definitions see Soil Survey Manual, pp. 169-172.

COMMITTEE ON CLASSIFICATION OF ORGANIC SOILS AND INTERPRETATIONS
National Soil Survey Conference, Orlando, Florida, Jan. 27-31, 1975

The National Organic Soil Task Force report submitted to the 1973 National Work Planning Conference of the Cooperative Soil Survey recommended that work be continued on the interpretation guides for organic soils. This recommendation was approved and a national committee was formed.

As a result of this approval, a continued effort was made over the past two years to revise and improve the original guides. The revised guides included in this report are the result of comments and suggestions of the (1) Regional Work Planning Committees, (2) small conferences held in conjunction with other work, (3) comments submitted through correspondence, and (4) through personnel contact with quite a number of people in various parts of the country. Needless to say the committee could not follow all the suggestions and comments submitted, or that all are in agreement with the report; however, the report represents the thinking of the majority of those who have contributed to this work.

The following interpretation guides are included:

(1) Preparation of management suitability groupings and ratings for specific crops
(2) Development difficulty rating
(3) Forestry
(4) Planning purposes
(5) Commercial use of peat.

It was necessary to exclude interpretation guides for wildlife as it was impossible to obtain a person to chair the subcommittee on wildlife.

Material on soil taxonomy has been omitted from the committee report. The committee is actively engaged in revisions and in additions to soil taxonomy. Some of the proposals have been circulated for review, others will be circultated this fall. It is planned to combine all proposed revisions and additions into one document. This document will then be submitted to the regional chairman assigned to review proposed amendments to the soil taxonomy.

Two research needs were submitted:

(1) Wind erosion
(2) Relationship between wilting point for plants and water content.

The Wind Erosion Research Laboratory. ARS, Manhattan, Kansas, is scheduled to do some on-site measurements of soil loss by use of a portable wind tunnel in Michigan in 1976. This should provide further information on the erodibility of different kinds of organic soils and the affect of cropping patterns on soil loss due to wind erosion. This will be a continuation of the research completed in 1973 on field samples tested in the wind erosion laboratory. A thesis by J. L. Brown, University of Minnesota, 1972 “Some Physical Properties of Organic Soil Materials” provides information on item (2) above.

Recommendations of the committee as amended by the work planning conference

(1) That the principal soil correlator's offices of the southern and western states take the leadership in preparing interpretation guides for organic soils (particularly for Agriculture and Forestry) for their states using the examples included in this report for the northcentral and northeastern states.

(2) That the guides prepared for the northcentral and northeastern states be reproduced and sent to these states for testing. Following the preparation of similar guides in the southern and western states that they also be sent to field for testing in their respective regions.

(3) That after the guides have been tested in the field for approximately two years the Regional Organic Committees evaluate the guides and make recommendations on revisions as well as what disposition should be made of the guides.

(4) That the proposed changes regarding SCS form-5 related to organic soils as submitted in the 1973 national work planning report, be considered if and when the form-5 is revised,

(5) That consideration be given to the development of difficulty ratings for uses other than for agriculture.

(6) That consideration be given to adding subsidence or shrinkage to the factors used in rating organic soils.

(7) That in conjunction with committee on "Water Relations in Soils" that (1) guides be prepared on soil-water characteristics as they relate to drainage and irrigation, especially hydraulic conductivity, and (2) that recommended depth to water table for maximum crop production be shown for all crops listed in the guides.

(8) That a subcommittee be formed to work on the "use of peat in the treatment of municipal waste water".

Following the meeting in Orlando, Florida the chairman contacted Dr. Rause Farnham regarding the chairmanship of this committee. If the formation of this new sub-committee is approved Dr. Farnham will chair the committee.

(9) That the committee on classification of organic soils and interpretations be continued to (1) review proposed changes as received or requested prior to submitting proposals to the Regional Taxonomic Committee and, (2) r&view proposed changes in the interpretive guides submitted by regional committees, revise guides as necessary and to assist in the correlation of interpretive guides between regions or major soil areas.

Comments and discussion on report

R. Grossman - Does everyone understand the implications that the penalty system will have on other soils as outlined in recommendations 1 and 2?

L. Bartelli - The guides using the penalty approach are being adopted for testing, not for final procedure .

W. McKinzie - Correct - I will substitute "for testing" in place of " for use" in recommendation No. 2.

L. Bartelli - Are the recommended changes in the SCS form-5 referred to in recommendation No. 4 being used in soil correlation?

W. McKinzie - Yes; however, there is no place on the SCS form-5 to record the data.

L. Bartelli - Will review the proposals submitted and will examine SCS Soils 5 form to see how they might be incorporated if and when form is revised.

R. Grossman - Request that recommendation No. 7 be a joint undertaking between committee 4 and the organic committee.

W. McKinzie - Agree - will add to the recommendation.

L. Bartelli - Recommend that a sub-committee be formulated to work on using peat in the treatment of municipal waste.

W. McKinzie - Will add this proposal to the committee recommendations. Will also contact Dr. R. Farnham regarding chairing this committee - if the formation of this new subcommittee is approved.

W. McKinzie - The organic committee recommended that a national committee on interpretations be formed and that the organic committee be a subcommittee of this committee.

W. Johnson - Committee would be too large. Must focus on the most urgent needs.

W. McKinzie - Will delete that recommendation.

M. Williams - Does item (1) in recommendation No. 9 dealing with proposed changes in soil taxonomy conflict with the Regional Taxonomic Committees?

W. McKinzie - NO. The organic committee will review proposed changes and assist in preparing proposed changes for submission to the Regional Taxonomic Committee.

W. McKinzie - The organic committee recommends that the report be accepted.

Approved.

Recorder: John Day,

The chairman would like to thank all those who have contributed to this report and especially Dr. Warren Lyon for his continued assistance throughout the past two years.

W. E. McKinzie, Chairman

Committee:

J. E. Witty
J. D. Nichols
W. C. Lynn
R. E. Lucas
R. S. Farnham
D. F. Slusher
Samuel Reiger
H. R. Finney
E. W. Neumann
L. P. Dunnigan
R. F. Fonner

Other contributors to the report.

Stephen Shetron, Mich. Tech. Univ., Houghton, Mi.
R. E. Smith, Manitoba, Canada
A. J. Klingelhoets, SSS, Wisconsin
Leslie W. Kick, SCS, N. Y.
Larry Brink, Forester MTSC, Lincoln
Jack Densmore, Forester, MTSC, retired
George Ally. Forester, SCS Wisc.
Rod Harner, SCS, Michigan
Neil Stroesenruether, SCS, Michigan
Paul Koch, SCS, Michigan
Louis Cook, Michigan State Highway Department
Larry Heinig, Michigan State Highway Department
Delbert Mokma, Michigan State University

GUIDE FOR THE PREPARATION OF MANAGEMENT SUITABILITY GROUPINGS AND RATINGS FOR SPECIFIC CROPS FOR ORGANIC AND ASSOCIATED MINERAL SOILS

Many workers feel that proper evaluation of the organic soils of a farm, county. or other planning unit necessitates comparison with mineral soils in the same area. The kind of rating approach developed for organic soils is not compatible with the capability unit system employed for mineral soils. Therefore the rating approach for organic soils was extended to encompass mineral soils with necessary modification of factors and penalties. The user can compare all the soils in the area of concern for a specific purpose.

An open-ended numerical rating and penalty approach was used in the development and testing of the proposed system. The open-ended system allows one to array the soils in relative order without immediate concern over the fit of absolute numeric differences within a given scale. It is difficult to use a positive progression from poor to good with the open-ended system because one does not know what number to put at the top. Once the system has been developed and tested, and we have a better idea of the relative numeric order of various ratings, then the scale can be compressed and inverted to give a positive rating system if that is considered more desirable.

As discussed earlier, the interpretive guides are not to replace on-site studies or investigations. The guides serve as an aid to general planning or as a means to rate or compare one kind of soil with another for a particular use. The penalty system gives the user explicit information on the factors involved and their relative importance in determining the ratings. The assignment of penalties is based on the experience and recommendations of persons who have worked with these kinds of soil. The user may or may not agree with the rating given a particular soil for the purpose he has in mind. However, with the information provided, the user can adjust the ratings, depending on his knowledge and on the intended use. The experienced user or technician may not gain much information from the guides. The less experienced user or technician will have a rational base for making decisions and a boost in the right direction. It is the latter group that should find the guides useful.

As the factors and ratings are likely to have different degrees of importance in different parts of the country, it appears that a management suitability grouping of organic soils for mechanized agriculture and ratings for specific crops or other use should be prepared by Land Resource Areas. Possibly one set of guides for the areas of the Lake States (Example attached), Southern Coastal States, Western States, and Alaska, and one for the Tropics would be ample. Preparing the interpretive guides by areas would allow for the selection of soil factors and penalties applicable for a particular area.

The following assumptions were used in preparing the Guide for the preparation of Management Suitability Groupings for Mechanized Agriculture:

Assumptions

1. Suitability ratings for drained conditions assume continued subsidence rates of ¼ inch to 2 inches annually; hence, for continuous use, as an organic soil the thicker organic materials are the moat suitable.

2. The organic suitability grouping is an interpretive classification designed to assess the limitations for the management of individual organic soils and for production of crops. Factors that affect production of the organic materials, productivity of the underlying material, adapted crops, management difficulty, and productive life span of the organic materials are used in determining suitability rating.

3. Good soil management, including cultural, and conservation practices that are feasible under a mechanized system of agriculture are assumed.

4. The soils within a suitability grouping are similar with respect to the degree of soil limitation but not necessarily similar with respect to the kind of limitation. Organic soils in group 1 have the least number and the least severe soil limitations and soils in group 7 have the greatest number and the most severe limitations.

5. Organic soils which have been reclaimed and developed for agriculture are classified according to any continuing limitations which may affect the production of agricultural crops.

6. The location, distance to market, efficiency of transport, financial state of the market, farm size, and sociological influences do not constitute criteria for suitability groupings.

7. Suitability groupings, suitability definitions, and penalty figures are subject to change as new information and methods concerning the manipulation of organic soils become available.

GUIDE FOR THE PREPARATION OF
MANAGEMENT SUITABILITY GROUPINGS FOR MECHANIZED AGRICULTURE FOR
ORGANIC AND ASSOCIATED MINERAL SOILS

(Revised September 1974)

Physical Features Used to Determine Suitability Grouping.

Factor	Penalty Factors
SOIL TEMPERATURE	
(Does not apply if growing degree days factor is rated)	
Isohyperthermic	0
Isothermic	0
Hyperthermic	0
Thermic	0
Mesic	0
Isomesic	0
Frigid	30
Cryic	60
Pergellic	90
GROWING DEGREE DAYS AIR TEMPERATURE	
(50° F. Base)	
3000 +	0
2200 - 3000	10
<2200	30
THICKNESS OF ORGANIC SOIL MATERIALS	
>52"	0
36-52	15
16-36	35
UNDERLYING MATERIALS--ORGANIC SOILS	
(Within depths of 51")	
Loamy	0
Clayey	5
Sandy	10
Coprogenous earth	2.0
Diatomaceous earth	15
Marl	15
Skeletal	30
Rock or fragmental	50
ROOTING DEPTH	
(Mineral Soils)	
(Inches)	
>40	0
20-40	5
10-20	10
<10	20

Factor	Penalty Factors
SLOPE	
(Mineral Soils)	
0, 1	0
2	10
3-6	20
6-14	35
14-20	50
20-35	65
>35	80
(Organic Soils)	
0-6	0
6-12	20
>12	30
EROSION	
(Mineral Soils)	
Slight	0
Moderate	5
Severe	20
SURFACE TEXTURE OR MATERIALS DOMINANT	
(In upper 16 inches)	
SL, FSL, VFSL, L) SIL, SCL, CL, SICL)	0
LS, LFS, SC, SIC, C (<60%)	20
S, C (60%)	35
Cobbly	50
Muck, mucky peat (sapric, hemic)	0
Peat (fibric)	20
Marl, coprogenous earth, diatomaceous earth	40
Gravelly phases of above	10
P.E. (MINERAL SOILS)	
(No Residual Wetness)	
>44	0
31-44	20
25-31	35
19-25	50
10-19	80
<10	90
AVAILABLE WATER HOLDING CAPACITY, MINERAL SOILS	
(To 60 inches for somewhat poorly or better drained soils)	
> 9"	0
6-9	15
3-6	25
<3	35

Factor	Penalty Factors
WATER CONTROL	
(Organic Soils - does not apply if tidal storm factor is rated)	
Adequate	0
Marginal	35
RESIDUAL WETNESS	
(Mineral Soils - does notapply if tidal storm factor is rated)	
None to Slight	0
Moderate	20
Severe	50
V. Severe	65
FLOODING DURING GROWING SEASON	
(Mineral Soils other than tidal storms)	
None	0
Slight	20
occ.	35
Frequent	50
TIDAL STORM FLOOD CONTROL	
Adequate	0
Marginal	45
REACTION (0.01M $CaCl_2$, upper 16 inches)	
<4.0 pH	20
4.0-5.0	10
5.0-6.0	0
6.0-7.0	0
>7.0	0
SALINITY (mmhos/cm)	
o-4	0
4-8	20
8-16	50
>16	75
ACID SULFATE SOILS (Actual or potential within 40")	
pH >4.5 (H_2O)	0
pH 3.5-4.5 (Borderline to sulfuric horizon or sulfidic materials as defined in Soil Taxonomy)	2.5
pH 13.5 (Sulfuric horizons or sulfidic materials)	75
STONINESS (Classes, mineral soils)	
<0.1 percent surface area	0
.1-3 " " "	50
> 3 " " "	80

Factor	Penalty Factors
COARSE FRAGMENTS (organic Soils-Wood >4" in dia., within 51 inches) (Percent of Volume)	
<1	0
1-10	5
10-25	10
>25	25
MINERAL OR LIMNIC LAYERS (Organic Soils - within depths of 51 inches)	
<2"	0
2-12"	20

PHYSIOGRAPHIC SETTING

Microclimate relief and size of area are not rated but are important properties to evaluate.

Suitability Grouping

The soil features listed above have penalty values assigned for each subdivision of the soil feature. As a guide to suitability grouping, add up the penalty numbers for the soil features applicable. Using this figure, determine the suitability grouping from the guide below:

PENALTY	SUITABILITY GROUPING * (↑ Increasing Potential)
o-15	1
20-30	2
35-45	3
SO-60	4
65-80	5
80-120	6
>120-	7
	8 (Miscellaneous land areas)

*The number of suitability groups can be adjusted as needed -- 3; 5, 7, or more.

EXPLANATION OF SOIL FEATURES

THICKNESS OF ORGANIC MATERIALS -- Penalties for thinner soils are related to the eventual destruction of the resource by subsidence, or the productive life span for use of an organic soil.

UNDERLYING MATERIALS -- refers to soils in lithic, limnic, or terric subgroups where the underlying materials are greater than 12 inches thick and soils in terric subgroups that have fragmental or sandy or sandy-skeletal particle-size classes. Penalties for underlying material are related to needed management inputs and to the suitability of the underlying material for agriculture as the organic soil subsides and is destroyed.

ROOTING DEPTH -- refers to soils with lithic or paralithic contact; duripan, petrocalcic, or placic horizon; or sand and gravel within depths shown.

WATER CONTROL -- refers to ground water level and flooding.

Adequate: Water control system must provide drainage for optimum crop yields and a water table sufficiently high to prolong the life of the soil.

Marginal: Water control less than adequate. Yields reduced because of poor water control and choice of crops is reduced.

None: No control measures for control of groundwater or flooding.

For most crops maximum depths of water table of 28 to 32 inches is the most desirable for crop production; 24 to 28 and 32 to 36 inches is less desirable and less than 24 and greater than 36 inches is marginal.

RESIDUAL WETNESS -- refers to wetness condition after drainage.

MINERAL LAYERS -- refers to soils in fluvaquentic or limnic subgroups and soils having fluvaquentic or limnic characteristics included in other subgroups as defined in Soil Taxonomy. This soil feature is not used in rating soils with mineral or limnic layers greater than 12 inches thick within depths of 51 inches. (Terric subgroups or limnic subgroups with limnic layer greater than 12 inches thick).

DEVELOPMENT DIFFICULTY RATING FOR AREAS OF ORGANIC SOILS

It is possible that two separate soils may have similar suitability ratings for agriculture but one may be more difficult to reclaim than the other. A development difficulty rating from 1 to 3 is proposed for all organic soils in an unreclaimed state. Brief definitions of the development difficulty groups follow:

Group 1 -- only minor reclamation is required. Minor reclamation is considered to be those operations which can be carried out by a single operator.

Group 2 -- major reclamation is required but is warranted when soils potential is high. Major reclamation is that requiring cooperation between adjoining operators or outside financial assistance or both.

Group 3 -- major reclamation is required and seldom warranted.

Physical Features Used to Determine Development *

Vegetative Cover

0 - Light (grasses, reeds, etc.)

20 - Moderate (Brush, small trees)

35 - Heavy (numerous large trees)

Surface Roughness

0 - None

35 - Holes and and mounds. l-2 ft.

50 - Holes and mounds, >2 ft.

Underlying Materials (within depths of 51")

0 - Loamy
10 - Clayey
20 - Sandy
20 - Diatomaceous earth
25 - Coprogenous earth
30 - Marl
40 - Skeletal
50 - Rock or fragmental

Coarse Fragments
(Wood >4" diameter volume % within depths 51")

<1 = 0
l-10 = 20
10-25 = 50
>25 = 100

Establishment of Adequate Water Control
(Including flooding & tidal flooding)

Slight = 0
Moderate = 50
Severe = 100

To determine the development difficulty group, add up the penalty points for features applicable. Using this figure, determine the group from the guide below:

Group 1 = 0-50
Group 2 = 50-100
Group 3 = >100

Recommendations for site development should be based on both the development difficulty rating and the suitability grouping for the soil after development.

Physical features used and penalty figures assigned are subject to change as new methods and more information as result of testing becomes available.

MANAGEMENT SUITABILITY GROUPING AND RATINGS FOR
SPECIFIC CROPS FOR ORGANIC SOILS AND ASSOCIATED
MINERAL SOILS
(**EXTENDED USE** ASSUMED FOR **THE** CROP INDICATED)
NORTH CENTRAL & NORTHEAST UNITED STATES

Physical Features	Management Suitability	Penalty Rating For Extended "se							
		Corn, Grain	Soybeans	Pasture	(Cool) onions, beets, carrots, & celery	(Intermediate) mint & potatoes	(Short Season) lettuce, radish, cabbage, & spinach	Sod	Wild Rice
Soil Temperature (does not apply if growing degree days factor is rated)									
Mesic	0	0	0	0	0	0	0	0	N.A.**
Frigid*	30	50	70	20	20	20	20	10	0
Growing Degree Days Air Temp. (50° F. Base)									
3000+	0	0	0	0	0	0	0	0	15
2200-3000	10	20	30	10	10	15	10	10	0
<2200	30	50	70	20	20	20	20	20	0
Thickness of Organic Materials									
>52	0	0	0	0	0	0	0	0	15
36-52	15	5	5	5	15	15	15	10	0
16-36	35	10	10	10	35	35	35	20	0
Underlying Materials (Within 16 and 51")									
Loamy	0	0	0	0	0	0	0	0	0
Clayey	5	5	5	5	5	5	5	5	5
Sandy	10	10	10	10	10	10	10	10	5
Diatomaceous Ea	15	15	15	15	15	15	15	15	15
Coprogenous Ea	20	20	20	20	20	20	20	20	20
Marl	15	30	40	15	15	15	15	15	15
Skeletal	30	30	30	30	30	30	30	30	30
Rock	50	50	50	50	50	50	50	50	50
Rooting Depth (Mineral Soils)									
>40 in	0	0	0	0	0	0	0		
20-40	5	5	5	0	5	5	5		
10-20	10	15	15	5	10	10	10		
<10	20	30	30	10	20	20	20		

*Penalty ratings will be less in transitional areas bordering mesic soil temperatures.

** N.A. -- Not Applicable

Physical Features	Management Suitability	Penalty Rating For Extended Use							
		Corn, Grain	Soybeans	Pasture	(Cool) onions, beets, carrots, & celery	(Intermediate) mint & potatoes	(Short Season) lettuce, radish, cabbage, & spinach	Sod	Wild Rice
Slope									
Organic Soils									
0 - 6	0	0	0	0	0	0	0	0	<½%
Mineral Soils									
0-1	0	0	0	0	0	0	0	0	
2	10	10	10	5	10	10	10	0	
3-6	20	20	20	10	20	20	20	10	
Erosion (Mineral Soils)									
Slight	0	—	—						
Moderate	0								
Severe	20								
Surface Texture or Material Dominant in upper 16 inches									
SL, FSL, VFSL, L SIL, SCL, CL, SICL	0	0	0	0	0	0	0	10	0
LS, LFS, SC, SIC, C <60%	20	20	20	20	20	20	20	30	0
C >60%	35	35	35	35	35	35	35	35	20
Muck, Mucky peat	0	0	0	0	0	0	0	0	0
Peat	20	20	20	20	20	20	20	35	0
Marl, coprogenous earth	40	40	40	40	40	40	40	40	40
Cobbly	50	50	50	20	70	40	70	100	N.A.
Gravelly phases of above	10	10	10	10	20	10	20	50	N.A.
Available Water Holding Capacity (Mineral Soils) To 60 inches									
>9 inches	0	0	0	0	0	0	0	0	0
6-9	15	10	10	5	15	15	15	15	0
3-6	25	25	20	10	25	25	25	25	0
<3	35	50	40	30	40	40	40	40	0
water Control (Organic Soils, does not apply if tidal storm factor is rated)									
Adequate	0	0	0	0	0	0	0	0	*
Marginal	35	35	35	10	35	35	15	25	

*Requires special water management.

Physical Features	Management Suitability	Corn, Grain	Soyb	Past	(Coo onio carr cele	(Int mint pota	(Sho lett radi cabb spin	Sod	Wild Rice
	Penalty Rating For Extended Use								
Residual Wetness (Mineral Soils, does not apply if tidal storm factor is rated)									
None to Slight	0	0	0	0	0	0	0	0	0*
Moderate	20	20	20	10	20	20	20	20	20
Severe	50	50	50	20	50	50	50	50	50
V. Severe	65	65	65	40	65	65	65	65	65
Flooding During Growing Season (Mineral Soils other than tidal storms)									
None	0	0	0	0	0	0	0	0	N.A.
Slight	20	10	10	5	20	20	10	20	N.A.
Occ	35	20	20	10	35	35	20	35	N.A.
Frequent	50	70	70	20	70	70	40	50	N.A.
Tidal Storm Flood Control									
Adequate	0	0	0	0	0	0	0	0	N.A.
Marginal	45	45	45	45	45	45	45	45	N.A.
Reaction ($0.01M\ CaCl_2$, upper 16 inches)									
<4.0 pH	20	20	20	20	20	20	20	20	20
4.0-5.0	10	10	10	10	10	10	10	10	10
5.0-6.0	0	0	0	0	0	0	0	0	0
6.0-7.0	0	0	0	0	0	0	0	0	0
>7.0	0	0	10	0	10	10	10	10	0
Salinity (mmhos/cm)									
0-4	0	0	0	0	0	0	0	0	0
4-8	20	20	20	20	20	20	20	20	20
8-16	50	50	50	50	50	50	50	50	50
>16	75	75	75	75	75	75	75	75	75

*Rated for trafficability after draining prior to harvest.

Physical Features'	Management Suitability	Corn, Grain	Soybeans	Pasture	(Cool) onions, beets, carrots, & celery	(Intermediate) mint & potatoes	(Short Season) lettuce, radish, cabbage, & spinach	Sod	Wild Rice
			Penalty Rating Pair				Extended Use		
Acid Sulfate Soils (Actual or Potential within 40")									
pH >4.5 (H_2O	0	0	0	0	0	0	0	0	0
pH 3.5-4.5 (borderline to sulfuric horizon or sulfidic materials as defined in Soil Taxonomy)	25	25	25	25	25	25	25	25	25
pH <3.5 (Sulfuric horizon or sulfidic materials)	75	75	75	75	75	75	75	75	75
stoniness (Classes Mineral Soils)									
<.1 percent surface	0	0	0	0	0	0	0	50	0
.1-3	50	50	50	50	50	50	50	100	50
>3	80	80	80	80	80	80	80	100	80
Coarse Fragments (Organic Soils -> 4" in dia., within 51") By Volume									
<1 percent	0	0	0	0	0	0	0	0	0
1-10	5	5	5	5	5	5	5	20	5
10-25	10	10	10	10	10	10	10	50	10
>25	25	25	25	25	25	25	25	100	25
Mineral or Limnic Layers (Within depths 51")									
<2 in	0	0	0	0	0	0	0	0	0
2-12	20	10	10	10	20	20	20	20	20

Rev. 7/24/74

INTERPRETIVE GUIDES FOR ORGANIC SOILS FOR FORESTRY

The forestry committee met on Wednesday and Thursday, November 29 & 30, 1972, principally to discuss interpretations for organic soils as used for the production of forest products. The committee report that came out of this meeting was reviewed at Regional Soil Survey Work Planning Conferences. A meeting of several of the committee members was held et Madison, Wisconsin on May 29 and 30, 1974 to review comments received. A working session was held in Lincoln, Nebraska on July 24, 1974, to review the 6/21/74 draft. The following is a revision of the original report based on the above reviews:

Ingredients of a Rating System

1. Interpretations for organic soils need to tie-in with those for mineral soils since both types of soils are likely to occur on one property. A rating system that will reflect the needed interpretations for both types of soil is desirable.

2. Ratings should reflect the suitability and productivity by tree species, not Just a general rating for "forestry."

3. Site index is the most commonly accepted means of assessing soils for potential productivity of woodcrops. The advantage of site index is that it is relatively easy to collect the required data on a number of soil conditions in the field. Since landowners are interested in the merchantable volume production per acre per year, site index needs to be related to cubic volume. These relationships are usually established on the basis of detailed research studies.

4. Soil interpretetions for forestry purposes should assist landowners to analyse the forest potential under the following two conditions:

   a. Where soil surveys are available. Here interpretations should be geared to the mapping units or foil series.

   b. Where soil surveys are not available. Under these conditions the key indicator soil properties need to be rated to help analyse the production potential of key species.

Productivity Classes

Several productivity class systems are in use. Most of these are developed on a regional basis.

Committee members recognized the need for a system of uniform productivity classes. However, we were not able to come up with one system acceptable to all. We suggest this be given further attention by the agencies involved.

Penalty Factors (Appendix A)

One method of analyzing the potential of an organic soil for forestry purposes is through a series of penalty factors. Appendix A is an attempt to assign penalty factors to selected indicator properties. This gives a basis for a general rating for forestry and a basis for analyzing soil potential for individual species. Naturally some indicator soil properties are more critical for one species than another.

Use Potential Groups (Appendix B)

The use potential groups in Appendix B were developed on general consideration of the penalty ratings in Appendix A. The use potential groups are for general evaluation of organic soils for forestry uses over broad areas.

Ratings for Soil Series (Appendix C)

Appendix C shows a listing of organic soils in the North Central and Northeastern states with site index indicated for suitable tree species for each soil series. The tree suitability is based on a general consideration of the penalty factors for key soil series, plus, soil-woodland site plot data from approximately 60 plots in Minnesota, Michigan, and Wisconsin. As additional data are collected the ratings by soil series in Appendix C can be improved.

Improvement of drainage of organic soils can have an important effect on productivity for forestry purposes. However, we have very little specific information to use as a basis for interpreting this factor on specific soil series and tree species. The site index data shown in Appendix C are based on a water table below 1 foot during a significant part of the growing season,

Appendix A

Penalty Factors for Forest Production on Organic Soils

Relative penalty ratings for individual factors that bear upon forestry production. The lower the number, the better the site. The penalty ratings were used as a tool to arrive at the Use Potential Groups, but are not used to compute suitability ratings in the system adopted.

Factor	Penalty:
1. Soil Temp. (climate)	
Hyperthermic	0
Thermic	10
Mesic	30
Frigid	50
Cryic	65
Pergelic	a0
2. Water Table (controlled-uncontrolled, average depth during growing season; not applicable for water tolerant species)	
depth to	
0-6"	50
6-18"	20
18-30"	0
> 30"	20
3. Reaction in Root Zone (0.01M $CaCl_2$)	
< 4.5 (any part)	30
4.5-7.3	0
> 7.3 (any part)	20
4. Salinity (mmhos/cm Water at 5 cm tension) average upper 16 inches	
o-4	0
4-8	20
8-16	50
> 16	75
5. Depth to restrictive layer (Lithlc, Paralithic) above water table	
> 16"	0
10-16"	20
5-10"	30
< 5"	40
6. Sulfur acidity (within 1 meter)	
Sulfidic materials or sulfuric horizon	100
7. Flooding 1/	
<4 Months (November-February)	0
4 to 7 Months (November-May)	40 (20)
7-9 Months (November-July)	75 (50)
>9 Months	100 (75)

1/Proposed by southern states. Use ratings in parenthesis for water tolerant species, such as cypress and tupelogum.

Appendix B

Use Potential Groups for Forestry for North Central and Northeast States
(Based on Most Limiting Factor)
Developed for Testing Purposes-Will be Revised as Data Becomes Available

FACTORS	GROUPS				
	1	2	3	4	5
Temperature Regimes	Hyperthermic Thermic	Mesic*	Frigid+	Cryic*	Pergelic
Water Table** in Growing Season	------------18-30"----------		6-18" > 30"	0-6"	
Reaction in Root Zone (CaCl)	4.5-7.3	> 7.3		< 4.5***	
Salinity	0-4mmhos/cm	4-8mmhos/cm		8-16mmhos/cm	> 16.0mmhos/cm
Sulfur Acidity					Sulfuric horizon** or Sulfidic Materials
Depth to Bedrock	> 16"	10-16"	5-10"	< 5"	
Slope	0-25%		25-45%		> 45%
Composition of Surface Tier	-------------Discontinuous-------------- Sphagnum			Continuous Spha (6-16" thick)	Continuous Sphagnum (> 16" thick)
Underlying Material Other than Bedrock	Use agricultural criteria if drained; not significant if not drained				
Flooding During Growing Season for water Tolerant Species	0-1 Mo	1-3 Mo	3-6 Mo		6 Mo

* High rainfall maritime climate to be rated one class higher.
XX Not applicable to water tolerant species.
*** This pH does not apply to maritime climates with >70" annual precipitation.
**** As defined in Soil Taxonomy.

Appendix C

POTENTIAL SITE INDEX OF SELECTED TREE SPECIES IN THE NORTH CENTRAL AND NORTHEAST STATES FOR GROWING ON ORGANIC SOILS
(based on water table > 1 foot during growing season.)

Soil Family and Series	TREE SPECIES: black spruce	tamarack	n. white cedar	balsam fir	black ash	red maple	silver maple	white spruce	white pine	Use Potential Group (Scale of 1 to 3) Appendix B
	SITE INDEX (Dominant total height at age 50)									
Typic Borohemists, euic										
Mooseleke	35	45	30	45	-	-	-	-	-	3
Rifle	30	40	30	45	-	-	-	-	-	3
Hydric Borohemists, dysic										
Tahquamenon										
Limnic Borohemists, euic										
Carlos										
Millerville										
Terric Borohemists, dysic										
Merwin	20	40	-	40	55	-	-	-	-	
Terric Borohemists, euic										
Tacoosh	20	40	30	40	55	60	-	-	-	
Typic Medisaprists, euic										
Carlisle	-	50	35			80	90	-	-	3
Houghton	-	50	35	-	-	80	90	-	-	3
Lena	-	50	35	-	-	80	90	-	-	
Fluvaquentic Medisaprists, euic										
Kerston										
Limnic Medisaprists, euic										
Muskego	-	50	35	-	-	90	90	-	-	
Edwards	-	50	35	-	-	90	90	-	-	
Terric Medisaprists, euic										
Adrian	-	50	35	-	-	90	90	-	-	
Linwood	-	50	35	-	-	80	90	-	-	
Palms	-	50	35	-	-	80	90	-	-	
Ogden	-	50	35	-	-	80	90	-	-	
Willette	-	50	35	-	-	80	90	-	-	

Appendix C (contd)

Soil Family and Series	black spruce	tamarack	n. white cedar	balsam fir	black ash	red maple	silver maple	white spruce	white pine	Use Potential Group (Scale of 1 to 5) Appendix B
	TREE SPECIES — SITE INDEX									
Typic Medihemists, euic										
Boots		50	35		-	65	75	-		
Limnic Medihemists, euic										
Cal-on										
Typic Borosaprists, dysic										
Loxley	30	50			-		-	-		
Typic Borosaprists, euic										
Lupton	30	50	40	55	55	60	-	-		3
Seelyeville	35	55	35	45	55	60	-	-		3
Hemic Borosaprists, euic										
Carbondale	30	50	35	55	55	60	-	-		3
Limnic Borosaprists, euic										
Rondeau										
Lithic Borosaprists, euic										
Chippeny	35	55	40	45	55	60	-	-		3
Terric Borosaprists, dysic										
Dawson	25	45			65		-	-		
Beseman	25	45			65		-	-		
Terric Borosaprists, euic										
Markey	35	50	35	50	55	70	-	-		
Tawas	40	50	35	50	55	60	-	-		
Cathro	35	50	35	50	55	60	-	-		3
Suamico	35	50	35	50	55	75	-	-		
Hemic Borofibrists, dysic										
Brophy	25	35			-		-	-		4
Limnic Medifibrists, euic										
Metogga										
Hemic Sphagnofibrists, dysic, frigid										
Lobo	20	30			-		-	-		5
Typic Borohemists, dysic										
Greenwood	35	45			-		-	40	54	4
Spalding	30	40			-		-	-		4

Interpretive Guides For Organic Soils For Planning Purposes

Organic soil materials are generally unsuited for engineering uses, particularly for use as a supporting base for construction or as construction materials themselves. Organic soils are avoided or circumvented, if possible, when encountered in areas where construction is planned. If areas of organic soils must be utilized, the engineer generally prefers to remove the organic material and backfill with mineral soil material. The depth of the organic material then becomes important. In some cases area* of organic soils cannot be avoided and they are too deep to remove under the given economic realities.

For instance, there are vast areas of organic terrain in Alaska, Canada, and in the Lake States where roads must traverse organic soils, and often it is not economically feasible to remove the organic soil and backfill with mineral soil material. Sometimes it is necessary to take a channel (open waterway) or a pipeline across an area of organic soils. In the New Orleans area, housing subdivisions are located on organic soils because there is no reasonable alternative.

For some Purposes, engineering construction is purposely placed on organic soils. Excavations for shallow water duck ponds are made to improve the wildlife habitat in bogs that have no open water. In the southern coastal areas, cattle are grazed on marshland and cattle walkways are built in heavy traffic areas. In many agricultural operations, the user likes to place small buildings on-site (on organic soils) for equipment storage. Farm access roads are a necessity for most agricultural operations.

For persons who must or who choose to undertake construction involving organic soils, some guides for preliminary planning are generally useful. The guides proposed here are designed to alert the user to the comparative hazards among the organic soils in the area. Criteria for the guides are based on observable soil properties.

As discussions about the guides progressed and development of the guides evolved, the term "planning" was substituted for "engineering" to better describe the context of anticipated usage of the guides. The term "engineering" seems to cause communication barriers between soil scientists and engineers, especially as the term is used In "Engineering Guides for Soil Interpretations." It was realized that most soil interpretations for organic soils are made for persons such as city planners, county planners, or their counterpart in the rural setting. Planning purposes generally require less detail than on-site investigations for a particular structure or road. Engineering interpretations are, to many people, synonymous with or closely akin to on-site investigations. Thus arises the communications barrier. The proposed interpretive guides for planning purposes may require more detail than provided by standard soil surveys. Of particular concern is the depth of organic soil. In this sense, the guides aim at "more detailed soil survey investigations" but do not require the intensity of on-site investigations.

Recent discussions have centered on guides for floating small loads on organic soils and for excavation and backfill operations, both taken largely in the context of road building. However, the guides are intended to be useful for a kind of operation and might include several specific uses. For instance, the guide for floating small loads on organic soils could apply to road building, construction of small buildings, cattle walkways or any other purpose where a light load is placed directly on top of the organic soil. Similarly, the guide for excavation and removal of organic soil materials could apply to any number of specific situations.

Some committee members have argued that the guides are well suited for training tools when SCS personnel work with planners, but that the guides are not well suited for making recommendations of a national scope, because they call for information not obtainable from normal soil survey operations, Others have argued that the guides serve as a base for fact gathering and decision making processes if and when the need arises. The present reviewers should evaluate, critically, the intended purposes for the guides as well as the practicalities of using them.

The guides were first set up on a numerical rating system with penalty points assigned for adverse conditions. The penalty points are summed to give a single numerical rating. The higher the number, the poorer the soil. A chart with relative comparisons of factors follows the interpretive guide for floating light loads on organic soils.

The guides are each comprised of several factors. A brief discussion of the factors and an explanation of some terms follow this paragraph. Following each guide is a blank rating sheet for use in tallying the penalty points for a given soil.

N-Value

N-value was adopted into Soil Taxonomy from the Dutch work. The N represents the grams of water per gram of clay. N-value can be derived by analysis and application of the following formula. However it was designed primarily for evaluation in the field by determining soil consistence or "ripening class" according to the criteria tabulated (modified from Brinkman and Pons., 1973. Symposium on Acid Sulfate Soils--Wageningen, Vol. I, page 182).

$$N = \frac{A \quad 0.2R}{L+3H} - \frac{- \quad 100-L+H)}{L+3H}$$

A = water content

R = silt + sand

L = clay

H = organic matter

DESCRIPTION OF SOIL CHARACTERISTICS (squeeze test)	RIPENING CLASS	N-VALUE
Stiff wet, very hard dry	Very ripe	< 0.4
Firm wet, hard dry; not possible to squeeze through fingers	Ripe (deformable)	0.4-0.7
Medium consistency. Squeezed between fingers with difficulty	Nearly ripe (slightly fluid)	0.7-1.0
Somewhat soft mud. Easily lost between fingers when squeezed	Half ripe (moderately fluid)	1.0-1.4
Soft mud, very easily lost between fingers when squeezed	Nearly unripe (very fluid)	1.4-2.0
Very soft mud, more or less fluid, dripping through fingers without squeezing	Unripe (liquid)	> 2.0

Still higher water contents (of liquid muds) are less easily estimated, but these occur only rarely. For field estimations, the above formula and table would give adequate precision in many cases.

Permeability

Permeability was not included as a rating factor in the guides for floating light loads or for excavation. It would logically appear as a factor in a guide for ditches and embankments. There has been some discussion concerning permeability (saturated hydraulic conductivity) classes as they are utilized for organic soil materials in soil survey reports. The following classes have been suggested for coefficient of permeability (K-values) for organic soil materials: It is recognized that unsaturated hydraulic conductivity may be as important as permeability in the management of organic soils.

Material	K-Factor
Sapric	0.2-6.0 inches/hour
Hemic	0.6-6.0 inches/hour
Fibric	> 6.0 inches/hour

Brief Explanation of Factors:

Factors affecting excavation

Depth to firm underlying material - The user often wants to know how much material has to be removed and what load the underlying material can support. Knowledge of the surface conformation of the underlying material is often very helpful, but generally takes more detailed investigations than envisioned for using the guides. Firmness of underlying material is indicated by N-value, developed in The Netherlands to classify "ripening" or firming of soft inundated sediments after they are drained. The N-value is the grams of water per gram of clay. Classes are tied to soil consistence, particularly the ease with which the material runs between the fingers when a sample is squeezed in the hand. Material with an N-value < 0.7 cannot be squeezed through the fingers. (See N-value for additional information.)

Logs and stumps - The presence of logs and stumps could be a hindrance in excavation operations. Evaluation is based on areal frequency. Classes are very generally conceived at this point. Details on size of logs or size of equipment were not included in the guide.

Factors affecting displacement (of soft materials at depths greater than 12 to 15 feet). A surcharge load is placed on the surface during construction to squeeze out the soft material.

Mineral strata - Stiff mineral strata could impede flow of the soft materials. The surcharge construction load would have to be increased accordingly. Thick mineral layers could give a "false bottom" impression during preconstruction testing-and lead to erroneous recommendations and possible failure.

Decomposition - The more fibrous the material, the more resistance to flow under the surcharge load.

Water content (of organics) - Water content is inversely related to density and firmness of organic material. Should a layer of "relatively dry" organic soil occur in the displacement zone, it could impede the displacement.

Factors affecting loads floated on organic soils

Depth to firm underlying material - Essentially want to know if there is a firm base at a comparatively shallow depth.

Logs and stumps - Material on surface of relatively greater importance than for excavation purposes. Want to know if logs or stumps have to be removed prior to placing mineral soil on top of the organics.

Kind of material - The structural stability varies with the kind of material. Woody peats tend to have larger pieces intermixed which give stability. Herbaceous peat tends to form a fairly rigid mat if the material is hemic. Sphagnum compresses substantially but forms an interlocking fibrous mat. Marl is soft when wet but firms up fairly well if drainage can be established. Diatomaceous earth should behave similar to marl. Coprogenous earth is comparatively fluid unless it can be thoroughly dried in which case a large, irreversible shrinkage takes place.

Decomposition - The more fibric the material, the more resistance to deformation and the more support it gives to a load. The fibers act in the sense of an interlocking mat. (Intended to recognize hemic or fibric layers in a predominantly sapric material.)

Mineral strata - The presence of mineral strata generally lends stability.

Surface densification (Depth to high water content; > 300%; organic soils - Drained organic soils densify and become increasingly firm above the water table. The field water content drops, and the-soil material changes irreversibly so that it will not again hold as much moisture as in the undrained state. The densification lends stability to the material and it better supports a load. Depth of water table could be used as a criterion, but the water table generally fluctuates seasonally. Bulk density could be used, but it is more difficult to determine than water content.

Surface "ripening" (Depth to soft material, N > 1.0; Hydraquents) - See explanation of N-value for "ripening" classes. Soft mineral sediments become increasingly firm-as water table is lowered. The surface layers lend structural stability even if soft materials are found at greater depth.

Additional material is appended at the end. Appendix I presents a hypothetical situation which is used for a rating example. Lack of time and expertise prevented the development of correlative guides for mineral soils so that the organic soils can be put in proper perspective. The latter needs to be done.

Interpretations relative to presence of permafrost are not included in the present draft. Other factors with regional significance may need to be considered also.

Interpretive Guide for Organic Soils for Planning Purposes
for
Floating Light Loads on Organic Soils

1. Farm access or rural roads (approximately 2-foot thick layer of road material placed on the organic soil)

2. Small buildings on organic soils (generally other than dwellings)

3. Cattle walkways

Factors :

Depth to Firm Underlying Material (N-value < 0.7)

< 16 inches	0
16-51 inches	50
> 51 inches	100

Logs or stumps (area1 percent)

< 0.1 percent	0
0.1-3 percent	10
> 3 percent	20

Kind of Material (materials dominant within 16-51 inches)

Woody	0
Herbaceoue	10
Sphagnum	20
Marl	20
Coprogenous	50

Decomposition

Fibric or hemic layer > 10 inches thick	0
Sapric	30

Mineral Strata (thickness between 16 and 50 inches) Doesn't apply to Terric subgroups

> 12 inches	0
4-12 inches	30
< 4 inches	50

Surface Densification (Depth to high water content; > 300% organic soils)

< 16 inches	60
16-51 inches	20
> 51 inches	0

Surface "ripenirg" (Depth to soft material; Hydraquents)

< 40 inches	100
> 40 inches	20

INTERPRETIVE GUIDE FOR ORGANIC SOILS FOR PLANNING PURPOSES
FOR
FLOATING LIGHT LOADS ON ORGANIC SOILS
(Relative Comparison of Factors and Ratings)

FACTOR	---------->Increasing Potential--->										
	10	9	8	7	6	5	4	3	2	1	0
Depth to firm underlying material, N < 0.7	> 51" (100)					16-51" (50)					< 16" (0)
Logs and stumps, areal frequency	> 3% (100)	0.1-3% (90)	< 0.1% (80)								
Kind of material dominant from 16 to 51 inches	Cop. (100)	sap. (90)		Sphag. (fibric) Marl Diat. (70)	Herb. (hemic or fibric) (60)	Woody (hemic or fibric) (50)					
Fibric or hemic layers (thickness between 16 and 51 inches, applies tc Saprists			> 10" (80)								
Mineral strata between 16 and 51 inches		4-12" (90)		> 12" (70)							
Surface densification (organic soils)		< 16" (90)		16-51" (70)			> 51" (40)				
surface "ripening" (Hydraquents)			< 40" (80)				> 40" (40)				

RATING SHEET FOR PLANNING PURPOSES
FOR
FLOATING LIGHT LOADS ON ORGANIC SOIL

FACTOR	Rating for named soil or condition			
Depth to Underlying Material				
Logs or stumps				
Kind of Material				
Decomposition				
Mineral Strata				
Surface Densification (Organic Soils)				
Surface "Ripening" (Hydraquents)				
TOTAL				

COMMENTS:

INTERPRETIVE GUIDE FOR ORGANIC SOILS FOR PUNNING PURPOSES
FOR
EXCAVATION AND REMOVAL OF ORGANIC MATERIALS

(includes displacement of soft materials below a depth of 12 to 15 feet)

Factors affecting excavation:

Depth to firm underlying material
(N-value < 0.7)

< 16 inches	15
16-51 inches	30
51-120 inches	75
> 120 inches	100

Logsand stumps (area1 frequency)

< 0.1 percent	0
0.1-3 percent	10
> 3 percent	20

Factors affecting displacement:

Mineral strata (thickness)

< 2 inches	0
2-12 inches	20
> 12 inches	50

Decomposition

Sapric	0
Hemic > 10 inches	20
Fibric > 10 inches	30

Water Content (of organics)

≥300 percent	0
<300 percent	30

RATING SHEET FOR PLANNING PURPOSES
FOR
EXCAVATION AND REMOVAL OF ORGANIC SOIL
(includes displacement of soft materials below a depth of 12 to 15 feet)

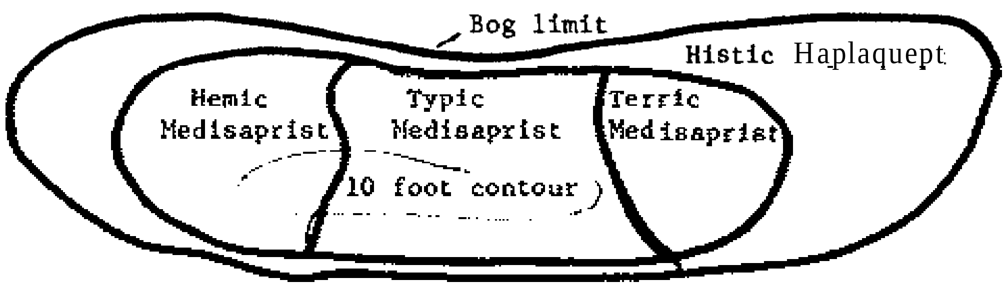
	Rating for named soil			
Factors affecting excavation				
Depth to firm underlying material				
Logs and stumps				
Subtotal				
Factors affecting displacement				
Mineral strata				
Decomposition				
Water content				
Subtotal				
Total				

APPENDIX I

Hypothetical situation for rating example

Stipulations

Organics are herbaceous, no forest influence.
Bog underlain by firm loam material
No mineral strata
Water table at 8 inches, little densification of surface.



RATING SHEET FOR PLANNING PURPOSES FOR FLOATING LIGHT LOADS ON ORGANIC SOIL

FACTOR	Rating for named soil or condition			
	Hemic Medisapris	Typic Medisaprist	Terric Medisapris	Histic Haplaquept
Depth to Underlying Material	100	100	50	0
Logs or stumps	0	0	0	0
Kind of Material	10	10	10	10
Decomposition	0	30	30	30
Mineral strata	50	50	0	NA
Surface Densification (Organic soils)	60	60	60	60
Surface "Ripening" (Hydraquents)				
TOTAL	220	250	150	100

COMMENTS : Penalty Approach - The higher the rating, the poorer the soil.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1975-631-968

NATIONAL COOPERATIVE SOIL SURVEY

Soil Survey Conference Proceedings

Charleston, South Carolina
January 22-26, 1973

Brown

Proceedings of -----

NATIONAL TECHNICAL WORK-PLANNING CONFERENCE OF THE COOPERATIVE SOIL SURVEY

Charleston, South Carolina
January 22-26, 1973

REPRODUCED BY

Soil Conservation Service
United States Department of Agriculture

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
Washington, D. C. 20250

June 4, 1973

SUBJECT: 1973 National Technical Work-Planning Conference of the Cooperative Soil Survey

TO: Recipients of Proceedings of the National Soil Survey Conference

Transmitted herewith are the Proceedings of the 1973 National Technical Work-Planning Conference of the Cooperative Soil Survey. These proceedings have no official status in their present form and should not be given widespread distribution.

Five (5) copies of these proceedings are being sent to each RTSC and about five (5) copies are being sent to the office of each state conservationist for distribution to the appropriate state experiment station soil survey leaders and to soil survey representatives of other agencies that are engaged in soil survey work in the state. In addition, sufficient copies are being sent for use by the state soil scientist, assistant state soil scientist, and soil correlator. The state soil scientist may wish to circulate one copy of this report among the GS-11 and GS-9 soil scientists; but in doing so, it should be made clear that the information, ideas, and data in these proceedings simply represent trends in thinking and progress of work. Thus, they do not necessarily represent official views, although many of the methods ultimately may be adopted officially.

Fifteen (15) copies are being sent to the Canada Department of Agriculture for distribution to key Canadian soil scientists.

William M. Johnson
William M. Johnson
Deputy Administrator
for Soil Survey

CONTENTS

CONFERENCE PURPOSE AND ARRANGEMENTS

Dirk van der Voet*

The primary purpose of this conference was to aid in the continued development and improvement of standards for carrving on all phases of soil survev work.

A new format was used at cur 1173 conference. There were no committee reports discussed by the entire conference, Each participant was assigned to one of four discussion groups. Prior to the conference each participant received a series of topics and questions that fell under four general subjects. These were operations, interpretations, investigations, and classification. At the conference the discussion groups discussed and made recommendations on the topics and questions previously supplied.

The topics under the general subjects were intended to center the discussion on major problems and needs. The questions directed discussion toward recommendations and solutions of the problems and needs. Each of the four discussion groups &voted some time to all of the topics and questions. Guidelines on the amount of time to he devoted to each general subject were provided. Discussion group chairmen used judgment and controlled the amount of time spent on each of the topics and questions.

Reports based on the discussion were prepared during the conference and presented on the last day of the conference.

Kenneth I:. Grant, the Administrator of the Soil Conservation Service, planned to address the group on the first day of the conference. He had to change his plans at the last minute however, and his address was given by William II. Johnson, the Deputy Administrator for Soil Survey.

On the first day of the conference a 15-minute presentation was given by a representative from each of the four regions of the land-grant universities and by the federal agencies in the Cooperative Soil Survey. These included the Bureau of Indian Affairs, Forest Service, and Agricultural Research Service. A Report of the Reconnaissance Soil Survey Task Force was given by Richard Huff, substituting for J. M. Williams who was ill. The status of Soil Taxonomy was reported on by John E. McClelland.

The second and third days of the conference were devoted to the discussion groups.

David G. Unger, Assistant Executive Secretary, National Association of Conservation Districts, addressed the conference on the fourth day. In addition, a report was given by W. E. McKinzie on the Organic Soils Task Force. There were also reports on Cartographic Developments, Accelerated Publication of Soil Surveys, and the Revision of the Soil Survey Manual.

Friday morning, the last session of the conference, was devoted to reports on Operations, Interpretations, Investigations, and Classification, based on the results of the discussion groups.

*Assistant Deputy Administrator for Soil Survey, Soil Conservation Service, Washington, D. C.

1973 SOIL SURVEY CONFERENCE PARTICIPANTS

A. Washington Office Soil Survey Staff

1. Johnson, W. M.
2. van der Voet, D.
3. McClelland, J. E.
4. Klingebiel, A. A.
5. Flach, K. W.
6. Simonson, R. W.
7. Gockowski, J. A.
8. Dideriksen, R. I.
9. Young, K. K.
10. McCormack, D. E.
11. Carlisle, F. J.
12. Powell, J. C.

B. RTSC Soil Survey Staffs

1. Bartelli, L. J.
2. Daniels, R. B.
3. Grossman, R. B.
4. Holzhey, C. S.
5. Langan, L. N.
6. McKinzie, W. E.
7. Nettleton, W. D.
8. Nichols, J. D.
9. Rourke, J. D.
10. stout, M.
11. Williams, J. M. (absent due to illness)
12. Witty, J. E.

C. State Soil Survey Staffs

1. Culver, J. R., Nebr.
2. Gallup, D. L., Idaho
3. Harmon, L. I., Iowa
4. Huff, R. C., Calif.
5. Johnson, R. W., Fla.
6. Latshaw, G. J., Pa.
7. Miller, F. T., N.D.
8. Perry, E. A., Ala.
9. Rieger, S., Alaska (absent)
10. Schmude, K. O., W.Va.
11. Watson, B., Vt.
12. Wells, R. D., S.C.
13. Gerald, T. R., S.C.

D. Other SCS

1. Grant, K. E., Administrator (unable to attend)
2. Huey, G., State Conservationist, South Carolina
3. Zitzmann, W. T., Resource Development Division (unable LO attend)
4. Bogner, N. F., Engineering Division (unable to attend)
5. Prout, C. T., Jr., Plant Sciences Division (unable to attend)
6. Cline, Marlin

E. Other Federal Agencies

1. Olson, 0. C., U.S.F.S.
2. Booker, R., BIA
3. Lunin, J., ARS

F. Land-Grant University Representatives

1. Fanning, D. S., Un. of Maryland, Northeastern Region
2. Ciolkosz, E., Pennsylvania State University, Northeastern Region
3. Hajek, B. F., Auburn University, Southern Region
4. Whitesidc, E. P., Michigan State University, North Central Region
5. Franzmeier, D. P., Purdue University, North Central Region
6. Simonson, G. II. , Oregon State University, Western Region
7. Nielsen, G. A., Montana State University, Western Region
8. Godfrey, C. L., Texas A and M, Southern Region

G. Canada

1. Day, J. H., Senior Soil Correlator, Soil Research Institute, Canada Department of Agriculture
2. McKeague, J. A., Soil Research Institute, Canada Department of Agriculture

DISCUSSION GROUP A

Battery Room

Chairman: J. D. Rourke

Members

Hajek, H.F.	Lunin, J.	Nichols, J.D.
Huff, R.C.	McKinzie, W.E.	Simonson, G.H.
Johnson, R. W.	Miller, F.T.	Young, K.K.

Time	Subject	Recorder	Advisor	Advisor Present
8:30-2:00T	Interpretations	Nichols	Klingebiel	8:30-12:00T
2:00-4:15T	Operations	Johnson, R.W.	McClelland Gockowski	2:00-4:15T "
4:15T-2:15W	Classification	Huff	Simonson	8:30-12:00W
2:15-4:30W	Investigations	Miller	Flach	2:15-4:30W

DISCUSSION GROUP B

Terrace Room

Chairman: L. J. Bartelli

Members

Carlisle, F.J.	Franzmeier, D.P.	Nielsen, G.A.
Culver, J.R.	Grossman, R.B.	Schmude, K.O.
Fanning, D.S.	Harmon, L.I.	Witty, J.E.

Time	Subject	Recorder	Advisor	Advisor Present
8:30-10:45T	Operations	Schmude	McClelland Gockowski	8:30-10:45T "
10:45-4:15T	Interpretations	Culver	Klingebiel	1:15-4:15T
4:15T-10:30W	Investigations	Witty	Flach	8:30-10:30W
10:30-4:30W	Classification	Harmon	Simonson	1:15-4:30W

#7

DISCUSSION GROUP C

Citadel Room

Chairman: M. Stout

Members

Ciolkosz, E.	Gallup, D.L.	Nettleton, W.D.
Daniels, R.B.	Langan, L.N.	Perry, E.A.
Dideriksen, R.I.	Latshaw, G.J.	Gerald, T.R.

Time	Subject	Recorder	Advisor	Advisor Present
8:30-2:30T	Classification	Latshaw	Simonson	8:30-12:00T
2:30-8:45W	Investigations	Perry	Flach	2:30-4:30T
8:45-2:15W	Interpretations	Langan	Klingebiel	8:30:12:00W
2:15-4:30W	Operations	Gallup	McClelland Gockowski	2:15-4:30W

DISCUSSION GROUP D

Ashley Room

Chairman: J. M. Williams (absent due to illness)
Marlin Cline

Members

Cline, M.
Holzhey, C.S.
McCormack, D.E.
Powell, J.C.
Rieger, S. (absent)
Watson, B.
Walls, R.D.
Whiteside, E.P.
Godfrey, C.L.
Booker. R.

Time	Subject	Recorder	Advisor	Advisor Present
8:30-10:45T	Investigations	Holzhey	Flach	8:30-10:45T
10:45T-8:45W	Classification	Powell (Rieger)	Simonson	1:15-4:30T
8:45W-11:00W	Operations	Wells	McClelland Gockowski	8:45-11:00W "
11:00-4:30W	Interpretations	Watson	Klingebiel	1:15-4:30W

NATIONAL SOIL SURVEY CONFERENCE

Sheraton-Fort Sumter Hotel
Charleston, South Carolina
January 22-26, 1973

Sunday PM January 21 3:00 - 6:00	Registration	Hotel Lobby
Monday AM January 22 8:15 - 9:oo	General Session - Charleston Room Registration	William M. Johnson Chairman
9:oo	Introductions, Announcements, etc.	
9:15	Welcome to South Carolina	George E. Huey state conservationist
9:25	Welcome to Charleston	J. Sidi Limehouse Chairman, Charleston County Soil and Water Conservation District
9:35	Address by Administrator Soil Conservation Service, USDA	Kenneth E. Grant
10:00	Group Photo and Recess	
10:30	Soil Survey in Canada	John H. Day senior Soil Correlator Soil Research Inst. Ottawa, Ontario, Canada

Statements by Land-Grant University Representatives

10:45	Northeast Region	D. S. Fanning Univ. of Maryland
11:05	Southern Region	B. F. Hajek Auburn University
11:25	North Central Region	D. P. Franzmeier Purdue University
11:45	Lunch	
Monday PM		
l:oo	Western Region	G. H. Simonson Oregon state univ.

Monday PM

Soil Survey

1:20	Bureau of Indian Affairs	Clark C. Stanton
1:40	Forest Service	0. c. Olson
2:00	Agricultural Research Service	J. Lunin
2:20	Discussion-Group Organization and Procedure	D. van der Voet
3:00	Recess	
3:20	Report of the Reconnaissance Task Force	J. M. Williams
4:30	Soil Taxonomy	J. E. McClelland
4:45	Adjourn	

Tuesday
January 23

Discussion Groups

GROUP A - Battery Room

GROUP B - Terrace Room

GROUP C - Citadel Room

GROUP D - Ashley Room

AM		PM	
8:30	Discussion	1:15	Discussion
10:00	Recess	3:00	Recess
10:15	Discussion	3:15	Discussion
12:00	Lunch	4:30	Adjourn

Wednesday
January 24

Discussion Groups

GROUP A - Battery Room

GROW B - Terrace Room

GROUP C - Citadel Room

GROUP D - Ashley Room

AM		PM	
8:30	Discussion	1:15	Discussion
lo:oo	Recess	3:00	Recess
10:15	Discussion	3:15	Discussion
12:00	Lunch	4:30	Adjourn

Thursday AM Charleston Room
January-25

8:30	Soil Survey and the National Association of Conservation Districts	David G. Unger Asst. Executive Secretary, National Association of Conservation Districts
9:20	Cartographic Developments	Jerome A. Gockowski
lo:oo	Recess	
10:15	Accelerated Publication of Soil surveys	A. A. Klingebiel
10:30	Revision of Soil Survey Manual	M. Cline
11:15	Report of the Organic Soils Task Force	W. E. McKinzie
12:oo	Lunch	
PM		
1:15	Consultations	
	Preparation of Reports	
	Tour	

Friday AM Charleston Room
January 26

8:30	Operations Report	R. I. Dideriksen
9:oo	Interpretations Report	K. K. Young
10:oo	Recess	
10:15	Classification Report	F. J. Carlisle
11:15	Investigations Report	D. E. McCormack
11:45	Conference summary	W. M. Johnson
12:oo	Adjournment	

SUMMARY OF REMARKS

by

Kenneth E. Grant+

It is a pleasure for me to participate in the Work Planning Conference of the National Cooperative Soil Survey. This program has been strengthened by cooperation at the local, state, and federal levels of government resulting in one soil survey program for the whole country rather than separate programs for each state. As a consequence, knowledge and experience gained within one state can be shared with adjacent states where similar soils are present.

A major goal of the Framework Plan for the Service is"a soil survey of the nation that is complete and current". This includes getting soil survey information to the public within 1 year of completion of the survey. High priority for surveys must be assigned to areas of high intensity use, of rapid land-use changes, and of critical sediment sources. The best possible use must be made of remote sensing equipment and automated data processing. The collection of laboratory and yield and other interpretative data must continue to be stressed to improve the quality of our work.

---

*Administrator, Soil Conservation Service, USDA, Washington, D. C.

We are pleased that the soil survey is supported by funds from local, state, and federal agencies. Soil surveys are of little value unless they are properly used, and agencies that contribute directly to the survey are more likely to use the information developed.

At the 1971 Workshop, I mentioned that in addition to the regular soil survey activities, three additional jobs lay ahead; reducing the backlog of unpublished surveys and revising the Soil Survey Manual and Soil. Taxonomy. We have made progress on all of these items.

In regard to unpublished soil surveys, eighty manuscripts were sent to the Government Printing Office in fiscal year 1972. This is twice the number we sent in 1969. Current plans are to send90 manuscripts to GPO in this fiscal year and 100 manuscripts in 1974 if finds and personnel are available. We are well along with the editing and map compilation for the manuscripts to go to the printer this fiscal year.

The new edition of the Soil Survey Manual has been written and a second draft is being circulated for review. We expect that before our next meeting in 1975, the Manual will be ready for publication.

Soil Taxonomy has been edited and is now in press. We expect to distribute it before July of this year.

At the present time, many of our soils memoranda are being shortened and revised. I have recommended that these memoranda be rewritten so that procedural details are omitted. These details will form the body of a national soil survey procedural handbook. An outline for this handbook is now being prepared. As each soils memorandum is revised, attachments will be issued that will form the nucleus for this handbook.

Quality control in our soil surveys deserves special emphasis. The information is being used more and more widely, particularly in areas where land investment costs are high.

Quality control requires care and timeliness in all elements of the correlation process for individual surveys. Care is needed in the construction of mapping legends, in the checking of field mapping, and in the review of descriptive legends and soil handbooks.

The Service is receiving ever-increasing demands for soil surveys and interpretations. With limitations on funding and personnel ceilings, we must look for new ways to increase the production of soil surveys with outside assistance. We must continue to explore cooperative cost-sharing agreements with state and local governments. Some counties are setting up soil scientist positions on their staffs and some states have soil scientists on experiment station or other state agency staffs. We should encourage states and counties to hire soil scientists so that they can share some of the heavy workload. In addition, we must be certain that our soil scientists spend their time working on soil surveys and not on other activities that less highly trained employees can handle. The use of biological aids is being investigated. Some states find that the use of small two-wheeled vehicles increases production.

The Intergovernmental Personnel Act may provide a useful means of accelerating the soil survey program. The Act provides a way by which an agreement may be signed with a local unit of government such as a county or state agency. If that agency pays at least 51 percent of an SCS employee's salary, the employee does not count against the SCS personnel ceiling. At the same time, he retains all of his rights, privileges, and benefits as a federal employee, such as retirement, insurance, leave, and so on. Under this arrangement, an SCS soil survey party leader could be detailed to a county government and provide the leadership for a soil survey in that county.

In some parts of the country, soil surveys are being used as the basis for land-use legislation and zoning ordinances. The new Colorado Land Use Law, Senate Hill 35, requires that each new subdivision plan must have a soil survey and interpretations before the plan is considered for approval. Other states have codes prohibiting certain kinds of construction where the soils have severe limitations.

In Canfield, Ohio, subdivision regulations of specific designs for foundations, widths of footings, basement walls, and drainage of footings are based on the kind of soil they will be placed in. This is the exception however. Most building codes still relate the width of footings to building height regardless of the kind of soil or drainage conditions.

Our published soil surveys and technical guides give the limitations of each kind of soil for many uses. This is good, but we need to do better. It isn't enough to raise red flags. We must be able to tell our users how they can overcome soil limitations, and how these soils can safely be used. We urge that you work closely with engineers, builders and planners on this question.

Entirely too many building problems occur because structures are placed on soils that cannot support them properly. Of course, if builders are willing to wait long enough, even their mistakes can pay off. The Leaning Tower of Pisa is a tourist attraction and a great place to visit -- but I wouldn't want to live there.

The fact is, we still have leaning towers -- and leaning homes -- and even leaning grain silos -- in modern America, in part because soil surveys are not being used to anywhere near their full potential. This is especially true -- and the problem is especially urgent -- in counties undergoing massive urban development. There are several reasons.

There may be a communications gap between the developers of technical information--such as yourselves--and the potential users of that information, such as planners and contractors. The surveys are difficult for non-soil scientists to understand, and they can become frustrated by their inability to glean useful information without considerable effort.

Sometimes land users do not know that soil survey information is available or how it is useful to them. Other times, private consulting firms may think the surveys are on-site soil investigations and are taking business away from them. We must make sure that people know what surveys are and what they can and cannot do.

Within financial and personnel limit?., the Service has the obligation to help provide a complete delivery system on soils information. We must not only produce accurate information, but we must give the interpretive assistance that will get this information into the hands of land-use planners and out on the land itself. Only then does the survey do its real job.

We must help people use this information as soon as it is mapped. Between the time of mapping and the delivery of a completed survey publication, land use planning goes on and buildings go up. Let people know when the information is available.

Easily understood soil survey interpretive maps will help. And the continued assistance of soil and water conservation district people and people from other government agencies is vital.

Now, let's look ahead to the coming year.

The Rural Development Act of 1972 authorized the Secretary of Agriculture to carry out a national land inventory and monitoring program. The soil survey staff will have a major role. It is likely that the sample areas used in the 1967 CNI will be used again. Some of the mapping will need to be updated, and we shall need to map additional samples. The kinds of data recorded are likely to be expanded. We hope to minimize the impact of this effort on our going soil survey program.

The Coastal Zone Management Act of 1972 authorized grants to coastal states to develop and implement management programs for coastal waters and associated land areas. The Secretary of Commerce has responsibility for its administration. In signing the Act, the President said he hoped that the next Congress would provide a National Land Policy Act, to cover all areas in which there is a critical concern for the environment. It seems probable that in the not-too-distant future, national land use policy legislation will be passed.

I am pleased to see the'effort that you in Soil Survey are making to do more with fewer people. Fortunately, this is the age of computers. Soil Survey will be placing all soil interpretations into computer storage for easy recall. The new Soils-5 form was developed for this purpose. After these data are placed in the computer, I am told that our capabilities for supplying information on soil resources will be tremendous.

The increased user demand for published soil data is only one of several reasons for the Cartographic Division's decision to develop the Advanced Mapping System. The primary goal of the "SCS-AMS" is to automatically produce press-ready negatives of soil maps for lithographic reproduction. We have received approval from GSA and the Systems Management Office of the Department of Agriculture for purchase of this system. We have assigned high priority to AMS, and prospects are good for issuing an Invitation for Bid in fiscal year 1974.

The advantages of high-altitute photobase sheets for progressive mapping are becoming apparent. Commencing with fiscal year 1969, a total of 93,239 square miles of high-altitude photography have been contracted and funded by state offices.

We have had problems in providing timely delivery of photobase sheets because of the NCSS acceleration. However, additional, fully operative, equipment has been installed in the Cartographic Division to reduce the time lag in providing photobase sheets to you.

We have just asked state conservationists to propose areas for the fiscal year 1976 NCSS publication schedule. Awarding a high-altitude flying contract early this year will give us an additional flying season before we have to have the photos. This will reduce the time lag between the availability of compiled maps and the text for printing. Production scheduling and coordination will be improved.

Personnel reductions in the Cartographic Division have affected their ability to fill all requests quickly. State staffs have been asked to review the priorities of their work requests and to limit them to essential services.

Last November, we combined certain technical services into the new Soil Survey Investigations Units at the RTSC's. The soil survey laboratories form the nucleus of these units for the Northeast, Midwest and West technical centers. Unfortunately, the growing costs of equipping and staffing a laboratory make it impossible to establish one in Fort Worth at present. Therefore, the southern region will be served by the Lincoln laboratory. We plan, however, to appoint a staff member in Lincoln to work exclusively with the Fort Worth Technical Service Center people.

There are problems -- 1 have mentioned some of them -- in your work. But I know you are fully aware that the current concern over the environment affords the opportunity to emphasize again and again that soils information should be a basic consideration in land use decisions.

What you have been saying for years is being said by others as well. Let me close by quoting from a recent editorial in a Pennsylvania newspaper.*

The editorial describes a new home development with flooded yards and leaky basements. The developer blamed it on -- quote -- "a bad soil and water problem. We just didn't know about it."

The editorial writer notes that a published survey of the entire county has been available to area developers since 1963, and that on-site inspection help from the local SCS office was available, at no cost. And he adds, "The developer was sleeping. They had a responsibility to know about drainage problems before they built."

The editorial concludes by saying, "Until determining suitability of soil is as common as title search before purchasing a home, we urge the public to beware. Don't buy a lot or build on it until first checking with the SCS."

---

*Delaware County Daily Times, Wednesday, November 29, 1972.

People want and need your help. Your work as soils experts is not complete when you have mapped, printed and published a survey. The information must be known and used to be effective. This part of your work is time-consuming and perhaps more difficult than the actual mapping. But people -- farmers, developers and land users of all kinds -- are not an interference with your work, they are the reason for it.

Soil Survey Activities in Canada

J. H. Day*

Soil survey has continued to provide soil data for capability ratings of soil for agriculture, forestry, recreation and wildlife. The agriculture and forestry sectors are based largely on soil survey information, but the recreation and wildlife sections are based on survey data only to a minor degree. The program is well advanced, with much of the basic characterization completed and most of the monetary aid agreements terminated. Based on a count of N.T.S. map sheets of scale 1:250,000 and average area of 3,981,400 acres the status of the program is as follows:

	Total Oct/72	Cordilleran	Great Plains	Ontario-Quebec	Eastern
Longitude divisions		116° +	88-116°	72-88°	72° -
Agriculture - published	84	4	41	20	19
- in preparation	55½	10	25½	13	7
Forestry - published	16	3	7	4	2
- in preparation	92	12	28	22	30
Recreation - published	63	19	13	12	19
- in preparation	132½	37	54%	21	20
Total Sheets	193½	54	67%	33	39

In the regular soil survey program emphasis is being placed on the interpretation of data for various uses. In the development of the capability to make these interpretations we have been assisted by personnel of the SCS, and by engineers and foresters. We have recently received authority to hire an engineer.

A major problem at the present is conducting exploratory soil surveys in unsettled forest and tundra regions. In these areas, soil information is urgently required for interpretations for trafficability, construction materials, subsidence due to permafrost and organic materials. The difficulties associated with these surveys, which are conducted in cooperation with geologists and foresters, are access for ground truthing of aerial photograph interpretation, and mapping units appropriate to the scale. An example of a soil mapping legend established by a geomorphologist is included. This kind of mapping program was conducted in the Mackenzie Basin in 1971 at latitudes 64 - 66, in 1972 at latitudes 60 - 64 and 66 - 68. The total acreage covered is about 76.7 X 10^6 acres. The manuscript maps were compiled at scale 1 inch equals 2 miles.

* Canada Department of Agriculture, Ottawa

Table 4. Distribution of Soils in the Upper Mackenzie River Area according to the Geological Survey of Canada map units.

Map Symbol+	Name	Parent Material	Topography	Drainage	Soils++ Dominant Soil	Zone (Section) 6S	6N	5	4	3	2	Dominant Vegetation+++
fO	Organic (fen)	Dominantly moderately decomposed fen peat derived from sedge, tamarack and mosses (greater than	Flat to very gently sloping, some with reticulate network of low (kim) ridges	Poor to very poor	Typic Mesisol	10	10	10	10	10	-	Sedge-bl or Sedge-Bl-tL in All Zones
pO	Organic (bog)	Dominantly moderately decomposed fibrous and/or undecomposed sphagnum peat, derived from black spruce, cladonia, feathermosses, Ericaceous and/or Sphagnum vegetation (greater than 6 feet thick).	Flat to gently sloping areas with occasional mounds (average relief in rarely to 6m); numerous steep-sided depressions and trenches.	Well to Imperfect	Cryic Mesisol Cryic Fibrisol	5	7	7	7	10	10	bS-fm-Er in Zones 6S and 6N; bS-lichen-Er in Zones 4 and 5; lichen-bS-Er in Zones 2 and 3
				Poor	Typic Fibrisol Typic Mesisol	5	3	3	3	+	+	Sphagnum or Sphagnum-bS in Zones 4, 5, 6S and 6N.
(g, m, s) AP	Alluvial flood-plain	Calcareous gravel and/or sand and silt; textures vary with the dominant material indicated first.	Floodplain and low bordering terraces; floodplains within mountains commonly scarred by braided channels; floodplains within plains region commonly with	Well	Cumulic Regosol	4	-	4	4	-	-	wS-wB, bPo-wS-[illegible]
				Imperfect	Gleyed Cumulic Regosol	3	-	3	3	-	+	[illegible] Equisetum, wS-bPo in Zones 4, 5 and 6S.
				Poor	Rego Gleysol	3	+	-	-	-	-	[illegible], bS-Al, bPo-Al in Zones 4, 5 and 6S.
					Cryic Rego Gleysol		+	3	3	-	-	
(g, s) At	Alluvial terrace	Calcareous gravel and/or sand and silt; textures vary with the dominant material indicated first.	Terraces with relief intermediate between terraces associated with Ap and Cp; level to slightly sloping surfaces, some interrupted with shallow channels and low terraces	Well	Degraded Eutric Brunisol Orthic Eutric Brunisol	6	6	6	5	-	-	wS-wB, wS-bPo, tA-wS, bPo, tA in Zones 4, 5, 6N and 6S;
					Cryic Orthic Eutric Brunisol	-	-	-	-	-	6	wS-wB, bS-tA, tA-bS in Zone 2.
				Imperfect	Gleyed Eutric Brunisol	1	1	1	1	-	-	bPo-wS, wS-bPo-Wl, tA-wS in Zones 4, 5, 6N and 6S;
					Cryic Gleyed Eutric Brunisol	+	+	-	+	+	1	[illegible], wS-bPo in Zone 2.
				Poor	Rego Gleysol	3	-	-	-	-	-	bS-Sh, bS-Sh-Er, bS-Sphagnum in Zones 4, 5, 6N and 6S;
					Cryic Rego Gleysol		3	3	3	-	3	[illegible] in Zone 2
gAf	Alluvial fan	Mostly calcareous gravel and some sand.	Gently to moderately (1°-8°) sloping fans and coalescent fans.	Well	Cumulic Regosol	-	-	6	6	-	6	Mainly wS, tA, Wl and Al in Zones 2, 3, 4, 5, 6N and 6S.
				Imperfect	Gleyed Cumulic Regosol	-	-	2	2	-	2	
				Poor	Rego Gleysol Cryic Rego Gleysol	-	-	2	2	-	2	
Cx^1 Cx^2 Cx	Colluvial Complex	Colluvium derived from entire range of surficial deposits, and bedrock.	Gently to steeply sloping irregular surfaces; Cx ≤ 5° Cx^2 > 5° ≤ 15° Cx > 15°	Well	Lithic Orthic Regosol Lithic Alpine Brunisol*	-	-	5	-	5	5	tA, wS, wB at low elevations and stunted alpine fir or wS, Er, lichen at high elevations in Zone 5. bS, wB at low elevations and Er, lichen at high elevations; cryoturbated surfaces are unvegetated in Zones 2 and 3.
				Imperfect	Gleyed Lithic Orthic Regosol Gleyed Alpine Brunisol*	-	-	2	-	2	2	
				Poor	Rego Gleysol Cryic Rego Gleysol	-	-	3	-	3	3	Sphagnum, bS-Sphagnum-Er in Zones 4, 3 and 5.

Investigations of problems related to soil taxonomy continue. I" 1971 a study tour of organic soils between Toronto, Ontario, and Halifax, Nova Scotia, resulted in the proposal of certain amendments in the Organic order. We were assisted in these discussions by the contributions of Drs. McKinzie, Lynn and Farnham, and the training session on field methods for fiber determination conducted by Lynn and McKinzie was especially valuable. At about the same time a tour of Western Canada between Saskatoon and Vancouver considered the Podzolic, Brunisolic and Luvisolic soils. Dr. K. Flach contributed materially to the discussion by explaining the taxonomy of Spodosols and Inceptisols and Dr. Vucetich of New Zealand contributed pertinent comments on the volcanic materials see" on the tour. Various proposals for modification of the taxonomy are now being considered.

Resulting from our joint endeavours in the preparation of soil and soil climate maps of North America, under the sponsorship of the FAO-UNESCO World soil map project, we have completed and have in press a two-volume work called "Soils of Canada. Vol. 1 Soil report, Vol. 2 Soil Inventory (with maps)." This should be available for distribution in one or two years.

One of our major current programs is the development of a data handling and retrieval system. This is called the Canada Soil Information System (CanSIS) and is comprised of several files.

I. A soil data file for identification, classification, location, site description, interpretation, methods, morphological description, chemical and physical data. Content of this file will be restricted to data collected on a named soil basis.

2. Soil Cartographic File for the geographic distribution of soils. Input will be for digitized soil maps. This file will be used for calculating acreage, color separations etc., and when combined with the soil data and other files, for local and regional land use and planning studies.

3. Administrative Geographic File for provincial municipal, county and other boundaries. Physiography, geology, climate boundaries will be stored.

4. Performance management file for crop yield data and soil response to various managements. This information will be interfaced with the soil data and soil cartography files.

Regional groups now are encoding soil profile data; one pilot project study is nearing completion. One of the first outputs is a list of Canadian soil names. copies of which will be forwarded to Frank Carlisle when available.

I wish to thank you for your kindness in inviting my colleague, Dr. J. A. McKeague, and me to participate in these meetings.

REPORT OF THE LAND GRANT COLLEGE REPRESENTATIVE OF THE NORTHEAST REGION

D. S. Fanning*

I am very pleased to be here todav and to have the opportunitv to pet together with manv old friends and to meet those of vou that I haven't known before.

In mv talk tcdav I want mainlv to comment on some of the committee reports that cane out of last vear's Northeast conference--particularlv on cane of the soil survey trends and needs that appeared to me to he reflected in them. I shall also comment brieflv on the reaction of sane of us in the region to the new format being used for this vear's national conference.

A tremendous amount of work was done bv the committees for the last Northeast conference. Also reports were made bv representatives from the various experiment stations on soil survev related research taking place at their respective stations. These are included in the conference proceedings for the perusal of those of vou who mav he interested.

The Environmental Soil Science Committee turned out a 271-page report in response to charges concerned with finding available information related to pedological aspects of environmental qualitv, hvdrologv, organic waste breakdown, and pesticides. Since it was too voluminous for the conference proceedings it was produced as Cornell Agronomv Mimeo 72-l. Those interested in it might contact Gerrv Olson, Department of Agronomv at Cornell, Chairman of the committee. Much of the information was retrieved from the computer information system on current research of the Cooperative State Research Service (CSRS). It was found that a tremendous amount of information is becoming available relating to the charges assigned. Disturbinglv, however, little of it was found to be related to specific soils in a meaningful fashion. So it appears that we in soil survey pro-s wed to do much more to get researchers to relate their work to soils as thev occur in the field.

The soil survev interpretations committee devoted a considerable part of its report to the need for, and how to promote, cooperation with geologists. Part of this probablv arose because we were able to pet John Hack of the U.S. Geological Survey to attend the conference and report on the USGS urban geology program, which he is heading up in the Baltimore-Washington area. To digress a bit, I might point cut that Hack's background is in geomorphology and he once collaborated in some soil geomorphology studies with C.C. Nikiforoff. Todav he and others like him represent the rapidlv growing fields of environmental and urban geology. I feel that one of the important questions that we in soil survev programs need to ask ourselves todav is, ha, should our work interact (both administrativelv and technicallv) with that of these and other geology and natural resource people? I think we should be trving to make our science and our programs mesh (or interface) with theirs. With the geologists, there are dangers from two directions. One is that we mav become jealous of each other as we both court the middle ground at the bottom of the soil scientist's soil. The other danger is that, to avoid conflict, we mav both tend to shun some C and R horizons near the bottom of the soil about which information is often needed todav to answer certain environmental and ecological questions, I feel that the solution lies in cooperation, and much can be said for a new marriage between soil science and geology--assuming that there once was one, as there has been right along between the soils, sediments. and rocks themselves.

*Department of Agronomv, Universitv of Marvland, College Park, Marvland

In the Northeast some new cooperation with geologists has been started. In Connecticut a soils-geology task force has been set up. This group has come out with a report (Bulletin 733 of the Conn. Agric. Expt. Sta. in New Haven) on "Use of Natural Resource Data in Land and Water Planning". In it a joint look is taken at a portion of a quadrangle in Connecticut with a view toward selecting a fictitious site for disposal of solid wastes. One of the problems encountered was the fact that the soil, geology, and topography mans for the area were all at different scales--illustrating a technical problem in meshing the information from different disciplines.

A cooperative earth science group, bringing together soil scientists, geologists and some planning people, has also been started in the Baltimore-Washington area. So some progress is being made in the Northeast at bringing earth science disciplines together hut much remains to he done.

A forest soils committee met at a Northeast conference for the first time in 1972. It made us aware that 60% of the Northeast is forested and that 3/4 of the privately owned forest land in the U.S. is in the Northeast. They pointed out that survey techniques different from those used for agricultural lands often need to be applied in the forested areas of the region.

Some forest soil interpretations that were considered critical in the Northeast were:

a. Species adaptation to specific soil conditions; especially of species not now present.
b. Relating site index to productivity.
c. Effects of TM harvest practices on soils.
d. Effects of spraying sewage effluent on growth and soils.
e. Erosion hazard--as related to road construction.

An interesting discussion on nomenclature developed in discussion of the Miscellaneous Land Types Committee report. By a vote of 29 to 1 the Northeast conference favored names like tidal marsh, borrow pit, etc. over soil taxonomy nomenclature. It was felt that the common names were better because they are much more easily understood by most users of survey reports. Thus, if taxonomic names are to be used in naming mapping units, sane reference to a common name better be retained too, e.g. Typic Udorthents, loamy skeletal--strip mine spoil.

Areas of highly man-disturbed soils continue to expand in the Northeast and more attention is being given to then. At Maryland sow cooperative work is being initiated with the National Park Service. People with the Park Service are interested in horticultural and landscape-architecture related problems of soils in Washington, D.C. An exhibit on urban soils is being prepared which will be built around some monoliths of disturbed soils from the mall area in Washington that have been prepared by Park Service workers.

A committee on Climate in Relation to the Soil Classification and Interpretations developed a soil temperature form for the Northeast and coordinated soil temperature studies in the region. From existing data, a map showing the distribution in the region of soils having mesic, frigid and thermic temperature regimes was prepared. The committee felt that more emphasis should be given to obtaining information on field soil moisture regimes, particularly considering landscape relationships.

A committee on Soil Family Criteria determined that families of soil taxonomy are not working cut very well in the region although they are useful for classification purposes. Phases of series often give much more useful information for interpretation purposes than phases of families. For example, the interpretations at the series level for soils in the same family are often much different depending on whether the soils are developed on glacial till, glacial outwash or a consolidated bedrock.

Other committee reports were on 1. Handling Soil Survey Data by Use of Electronic Equipment, 2. Histosols and Tidal Marsh Soils, and 3. Benchmark Soils, Technical Soil Monographs, and Soil Survey Laboratory Investigations.

In closing, let me say a few words about the new format being used for this national conference--the attempt to break away, at least partially, from the committee system and to install discussion groups. I feel that certainly some good questions have been set forth for our discussion groups to consider and that much good is bound to come out of the conference. I fully intend to reserve final judgment about the new format until the conference is over. However, I have sounded out several of our workers in the region and I'll try to pass them along for whatever they are worth.

Some feel that this year's format will be good, particularly at this time when several soil survey personnel and program changes have and are being made. However, they feel that the new format probably would not be the best for future conferences--at least not without some modifications. One of my colleagues has said that we need a conference organized like this one about once a decade.

Others are more critical. Dave Hill of the Connecticut Experiment Station puts it this way:

> Frankly, I am very skeptical about this year's format. Committee Lark has always been the heart of National and Regional Conferences. This method allows scientists assigned to 1 or 2 committees to concentrate on a limited number of subjects and do a thorough job in reaching conclusions. The new format I am afraid may lead to too much generalization, uneven allocation of tire on particular topics, and difficulties in making recommendations for the regional conference to follow up on. For example, several committees of the Northeast Region had specific recommendations for the National Conference to consider. How are these going to be handled?

Thus, I guess sane of us are getting somewhat "old-foggevish" and resistant to change. But I wouldsay that if this year's approach makes us stop and ask just how do we want to handle our affairs, it will have served a useful purpose. However, if our survey is to be truly cooperative it seems to me that the Experiment Stations should have a stronger voice in selecting the format of future conferences.

REPORT OF THE LAND GRANT COLLEGE REPRESENTATIVE OF THE SOUTHERN REGION

B. F. Hajek*

The Southern Regional Technical Work-Planning Conference biennial meeting was held at Virginia Polytechnic Institute and State University, Blacksburg, Virginia on May 2-4, 1972. Seventy-one individuals participated in the conference, representing twelve land grant colleges and experiment stations, Puerto Rico, the Soil Conservation Service, Agricultural Research Service, Forest Service and the Virginia State Health Department.

The members welcomed the participation of the following invited speakers:

Dr. J. E. Martin, Dean of Agriculture, VPI & SU.
Dr. W. J. Hargis, Director, Virginia Institute of Marine Science who discussed Wetlands Research,
Dr. J. Cairns, Director, Center for Environmental Studies, VPI & SU. Dr. Cairns outlined the various phases of environmental research being conducted by the center. He stressed the need for predictive models which simulate aspects of the environment. Predictive models are needed to allow management to take full advantage of the assimilative capacity of environmental systems and to evaluate alternate practices.
Mr. W. M. Johnson, Deputy Administrator for Soil Survey, discussed developments in the National Soil Survey Program.

The conference worked through 12 committees. Each committee presented a report which was published and is available to the members of this conference, consequently I will not present a summary of each committee report.

During committee report presentations, considerable discussion was directed to the following topics: application and interpretation of soil surveys, handling soil survey data, benchmark soils, environmental soil science, and changes in the classification system.

Application and Interpretation of Soil Surveys - The committee requested that the cooperation of research workers in all areas of soil science should be actively solicited in the development of interpretive tables for soils. Interpretive soils information should be simplified to obtain maximum use. It was recommended that in order to attain uniformity within the Southern Region, ADP programs developed for the National Cooperative Soil Survey be made available to all cooperative agencies to avoid duplication of effort. In addition further study should be given to kinds of generalized "user maps" that can be generated from ADP for land use planning. The committee on benchmark soils recommended that each state start and maintain a data file on benchmark soils to be assigned. Copies of this data would be supplied on request . The number of soils proposed in the past for benchmark status should be reduced, and when sufficient data are available the information should be

* Agronomy and Soils Department, Auburn University, Auburn, Alabama.

published as groups of soils perhaps at the suborder level. A report giving a summary of research projects involving environmental quality within each southern state was presented at the conference. In addition a committee chaired by Dr. Boul (NCS) presented preliminary guidelines for rating soils for organic waste disposal. The regional committee for changes in the classification system recommended that states adopt a procedure that allows for channeling proposals through the state soil scientist or state soil survey representative.

Comments about Supply and Demand

Anyone associated with soil survey can recognize the current increasing demand for interpretative information obtained only by soil survey activities such as mapping and classification. Two types of requests arc common, one for information not known to us thus requiring investigation, the other for interpretations from available 'data.

You are aware of the many things being done to help satisfy this ever increasing demand. I would like to mention some current activities which probably will not help as much as we might believe. Although needed, I doubt if automatic data processing, computer map making, remote sensing, accelerated soil Survey publication, or changing the form of published reports will Satisfy our current demand for soil survey information.

The information obtained from computers is no better than the input. Computers are not miracle producing devices, they cannot print-out satisfactory interpretations without input data. In addition you cannot write a perfect, general, program that will accept all soils data and retrieve all possible combinations in a useable form. Often scientists cannot obtain data in a form compatible with a program format. Computer "user" maps are a reality but to use this technique, mapping must be correlated and complete. Remote sensing, other than the black and white photography we use, is of little value for mapping in its present state of development.

I have also reached the conclusion that writing a soil survey report that is easily understood by all potential users is just about impossible. I have no doubt that many of your associates are like many of mine. If they need information they call you before they will try to look up a bit of soils information in a soil survey report. I do the same thing. For example, we have several good bulletins on turf, but if I want to know some specific bit of information on turf I call our turf specialist. Why? He usually provides more information in less time and time is valuable.

I believe many soil survey users in the future will continue to call a soil scientist for soil survey information and I think the calls will increase. Automation will only make more information available in less time and improve the predictions we make. Thus we must consider the use of increased numbers of well trained soil scientists as an alternative solution.

REPORT FROM NORTH CENTRAL REGION
LAND GRANT UNIVERSITIES

D. P. Franzmeier*

The committee of university people in Soil Survey in the midwest is NCR-3. Cane Whiteside and I are representing it here. This committee coordinates the efforts of university personnel, and has representatives from federal agencies, but has no funds for research projects. One of the concerns of the committee has been the degree of participation of university people in the soil survey program. A questionnaire has been circulated to determine the extent of their participations in various aspects of the soil survey program and to find out what specific problems they have experienced. Several questionnaires have not yet been returned, but most of those returned indicate a de-e or little change in the degree of participation in field activities of the soil survey. On the other hand several states have added new extension positions in land use which involves interpretation of soil surveys. Sane of the problems in the cooperative survey that were expressed by more then one state are:

1. New surveys are conducted in counties that already have relatively good surveys (published in 40's and 50's) while other counties have never had a survey.

2. Willingness of counties to share costs of a survey is given too much importance in determining the priority of surveys. Experiment Stations have little input in determining priority of counties for the survey.

3. States do not funish enough money for soil survey.

4. Air photos are sometimes poor quality.

In some states in the region soil scientists are actively engaged in studying and promoting legislation for registration of Roil scientists.

In Nebraska, a few years ago, legislation was introduced but failed to pass in the state legislature. In North Dakota, a bill is now being introduced and debated. Wisconsin, North Dakota, and Minnesota have state societies of soil scientists that are studying legislation.

In 1972, a funded research project, NC-109, was approved through 1976. The project, Soil Landscape Characteristics Affecting Land Use Planning and Rural Development, has two objectives: 1. To define, map, and evaluate soil landscape units in tens of alternative land uses in rural and suburban areas, and 2. To develop and publish soil landscape guides for land use planning and rural development. Some states have new funds for research projects in their areas; others are reporting projects that are related to the objectives but are funded from various sources. The kinds of projects being conducted are:

1. Developing general soil maps and interpretive material (for land evaluation, waste disposal, etc.) for counties, groups of counties, and states.

2. Developing computer programs to assist in various phases of soil interpretations,

*Department of Agronomy, Purdue University, Lafayette, Indiana

3. Updating older surveys by photographically enlarging line maps and transferring the lines to airphoto backgrounds and determining the composition of units.

4. Studying the hydrology, erosion, and runoff characteristics of soils as they pass from agricultural to urban use.

5. Applying remote sensing techniques to soil survey and to determining land use.

6. Studies of how soils absorb septic tank effluent and how soil information and percolation tests can be applied to land use planning.

The NCR-3 committee initiated the newsletter Soil Survey Horizons 14 years ago to help soil surveyors exchange information, ideas, and anecdotes about their profession. Francis Hole has devoted much effort to keeping the publication moving. Production of the newsletter has been a spare-time activity among several of us and it sometimes does not get the attention it deserves. We are now wondering if it would be appropriate to propose that the publication be supported on a larger base by being sponsored and published by the Soil Science Society of America. This suggestion has not been thoroughly thought out nor has it been brought to NCR-3. However, we would like to get the opinion of this group as to the feasibility of the proposal. The newsletter could include these kinds of articles:

1. Reports on field observations of field soil scientists.

2. Accounts of innovations in using soil surveys and benefits of their use.

3. Description of new kinds of field equipment and field-laboratory procedures (pyrophosphate extracts, calcium carbonate equivalent, etc.)

4. Proposed changes in Soil Taxonomy and actions taken on the proposals.

5. Progress reports on items of current interest (revision of Soil Survey Manual, automatic data processing, airphotos, etc.)

6. Items of technical interest to the survey--as have been published in Soil Survey Technical Notes.

7. Reprints or condensations of articles published elsewhere, but of special interest to soil survey people.

8. Anecdotes, humor, poetry, etc.

9. Information about registration programs.

10. Information exchange about high school and collegiate soil judging contests and manuals for contestants.

11. Personnel changes, necrology, etc.

The advantages of sponsorship by the SSSA may be:

1. The backing of a large, established professional society.

2. Expertise in editing, printing, and circulating the publication and collecting payments. Editors could spend more time on content of articles, rather than mechanics of production.

3. Possibly more prestige in having a" article printed.

We believe that the proposal would need the backing of this group if it were to succeed. Soil scientists would need official encouragement to submit articles. Also, it would help to have a policy whereby a short, informal article could lx suhnitted without several levels of review to encourage spontaniety in writing articles--if they aren't written and submitted while the idea in fresh, their probably never will be written. Details of the name, leadership, subscription price, etc. could be worked out. It should be possible, perhaps, to issue it to members of the society at a nominal cost and to nonmembers at a slightly higher cost. We have talked about increased professionalism among soil scientists and this may be a chance for action.

In northern Illinois and Indiana in the Chicago area we have an example of the interaction of proposed land use changes and people. Recently Congress authorized the Corps of Engineers to draw up alternative plans to assure clean water supplies for the metropolitan areas around Chicago, Cleveland-Akron, Detroit, San Francisco and Boston.

For the Chicago area the Corps produced several alternative proposals for treating wastewater in a project called C-SELM, Chicago South End of Lake Michigan. The area covers 2600 square miles of lard in Illinois and Indiana and is populated by over 7 million people. The Engineers proposed three basic kinds of plans to purify wastewater: biological, physical - chemical, and land treatment. According to their predictions the land-treatment plan costs about 60 percent as much, produces cleaner water and causes much less air pollution than do the other two methods. The land-treatment plan calls for irrigating 134 inches of water per year, in addition to the normal 36 inches of rainfall, to poorly drained sandy soils in northwestern Indiana. A conduit, perhaps 20 feet in diameter would conduct the water to the site for treatment. The land requirement for the system would be around 50,000 acres for aeration and storage lagoons and 300,000 acres for irrigation of effluent. The water, after passing through the soil, would he removed by a tile drainage system and pumped back into the Lake Michigan watershed. According to original estimates 25,000 people would have to he relocated from their present homes when the system in installed, but these estimates have changed more recently to allow for little displacement of people.

These plans were made with little input from agricultural scientists. especially those familiar with local conditions, and with no input from citizens of the area involved. The plans were announced in September with the assumption that farmers would he anxious to be involved in the project and receive water and nutrients from the system. The farmers, however, already get average yields of 135' bu/acre of MT" in the counties involved using high fertilizer rates and are bothered more by excess water than by drought. They didn't feel they needed more water, especially wastewater from the Chicago area. Their neighbors in town agreed with them, and consequently the proposal met with almost 100% opposition. The announcement was made in September, in the middle of political campaigns, and candidates for state and federal offices tried to outdo their opposition in opposing the project. Consequently hills have been introduced in the Indiana legislature that would forbid interstate transport of wastewater without specific consent of the legislature, and similar proposals are being made at the federal level. There are some reservations about the technical details of the proposal; however, it appears to be doomed, for the present at least, not because of scientific reasons, but because of the reaction of the people involved.

Now, after the initial reaction subsided, citizens of the area involved are becoming more interested in learning about irrigation of effluent and some educational programs have developed.

This summer, June 4 to 15, a 2-week intensive course in airphoto interpretation of land forms and soils will be offered at Purdue. Prof. Miles in Civil Engineering will teach the course. It will consist of a condensation of longer courses he teaches. Graduate students and soil scientists who have taken these courses have been impressed with how much more they see in airphotos after they have taken these courses. We hope that several soil scientists can take the intensive course so that they can evaluate it as to how it fits their needs. If it is valuable to them, and to the survey, this course could be taught on a regular basis. It carries 2 hours graduate credit. In the long-run, it should be a good investment in a soil scientist's career.

REPORT OF WESTERN REGIONAL TECHNICAL WORK-PLANNING
CONFERENCE OF THE COOPERATIVE SOIL SURVEY
AND REPORT OF THE SOIL SURVEY WORK GROUP

G. H. Simonson*

The first part of this report describes a new Western Regional research project involving members of the Soil Survey Work Group.

The second part of the report is a summary of the Western Regional Technical Work-Planning Conference.

I. Regional Research Project: W-125, Soil Interpretations and Socio-Economic Criteria for Land Use Planning.

This new project was initiated July 1 in response to the high priority assigned by National and Regional Task Force Reports to needs for interdisciplinary regional research and information related to land use planning. The participating project leaders are primarily soil scientists and agricultural economists. Contributing projects will involve work with planners, engineers and other disciplines under one or more of three objectives. Most of the projects are in planning or initial phases at this point.

Ten members of the Western Soil Survey Work Group are participating in the regional project. The objectives with some of the contributing projects are indicated below.

Contributing projects under objective I deal with physical and socio-economic causes and consequences of urban enroachment on rural lands. These projects include case studies in the Vancouver, Washington area, the San Joaquin Valley in California, the Las Cruces area in New Mexico, the Willamette Valley in Oregon and the Wasatch front in Utah. These studies include inventory of land use development patterns in relation to physical characteristics and suitabilities of the land.

Several other projects are contributing to objective I. Hawaii is studying institutionalized criteria that influence land use. Colorado is defining critical areas for agricultural production of unique value meriting protection under the state land use plan. California has begun a study of the economic impacts of remote recreational subdivisions on county government.

Objective II deals with identification and presentation of soil and landscape data needed by planners and other users. A regional manual is planned as one product of participating projects. Development of local and state informational manuals or materials will

*Department of Soil Science, Oregon State University, Corvallis

provide a logical basis for the regional manual. Colorado has published a State Land Use Planning Handbook that identifies information sources and describes the planning process. Montana has developed overlay maps of soils in the Gallatin Valley to contrast suitabilities for different uses. They also are documenting examples of costs associated with misuse of soil resources. Oregon is participating in a multi-discipline study of integrating soils and other resource inventory data and its effective presentation for land use planning, utilizing aerial photography/satellite imagery.

Objective III involves evaluation and development of data and interpretations for land use planning, and means of overcoming soil limitations. Nevada has made a small-scale map and report of Freeze-Free Seasons in relation to topography for state-wide economic and agricultural planning. The relative erodibility of major soils in California is being measured to develop predictions of soil-loss needed for land use planning. New Mexico is studying statistical correlations of soil characteristics with saturated permeability. Oregon has begun a study of septic tank malfunction records to determine relationships to soil parameters and to evaluate criteria for suitability interpretations of soils. Washington is evaluating soil chemical characteristics relevant to land use planning. Montana has done some work with computer analysis of soil data for predictions of engineering classes.

II. Summary of the Western Regional Technical Work-Planning Conference of the Cooperative Soil Survey. Honolulu, Hawaii, January 23-28, 1972.

The excellent conference arrangements were by hosts Harry Sato, Soil Conservation Service, and Goro Uehara and L. D. Swindale, University of Hawaii. Field trips were held on the island of Hawaii to view soil development and land use on relatively young volcanic deposits over a wide range of precipitation and on the other landscapes of Oahu with Oxisols and Ultisols. Some of the presentations during the meetings included: Tropical Soil Fertility-Professor Robert Fox; Soil Data Processes for Agricultural Development-Dr. L.D. Swindale; Land Use Law in Hawaii-Mr. Dean Austin; Determination of Erosion Condition Classes by the BLM - R. Kuhlman; National Soil Survey Program- W.M. Johnson; and Recent Soil Survey Developments in the Western Region- J.M. Williams.

Ten Committees presented reports developed through prior correspondence and study by members. Brief summaries of committee reports follow.

Application of the Soil Classification System

The committee considered use of depth and duration of water tables to define drainage classes. They agreed that soil water table regimes should replace the present drainage classes. They proposed for discussion, four classes of water table duration at 20 inches or less depth, related to taxonomic classes of wet soils. These are the same water table classes to be discussed at this conference. The committee also emphasized the need for detailed descriptions of water tables in particular soils.

Handling Soil Survey Data, Soil Survey Investigations and Benchmark Soils

The main work of the committee was assembly and distribution of Benchmark Soil lists showing their classification and status of characterization work. The number of familes on the list were reported for each state.

Soil Survey for Forest and Range Soils

The West is especially concerned with the problems of soil survey for these lands. Mapping of such areas is rapidly expanding, the terrain is often difficult to travel and observe, and the land use is generally not intensive enough to justify a high cost survey. The questions considered involve intensity and level of detail, kinds of mapping units, kinds of interpretations, and survey methodology.

The committee agreed that reconnaissance surveys were adequate for most areas. The size of survey area was immaterial and intensity of management was the main consideration. They suggested that the soil inventory should be designed by looking at the "problems to be solved" in land use planning and management. Flexibility is needed in mapping unit nomenclature, and however named, the quality of the mapping unit description is of main importance. Size of delineations is related to natural landscape units and landscape complexity as well as management requirements. Interpretations are needed for taxonomic units, mapping units and for groupings of mapping units. More quantitative data are needed in support of interpretations. Remote sensing techniques and interdisciplinary inputs from geology, hydrology and plant ecology are survey methodologies needing more consideration.

Climate in Relation to Soil Classification

Dr. Arkely presented an analysis of soil temperature data collected on 597 sites in ten states over several years. He outlined a stepwise procedure for predicting mean annual soil temperatures using different amounts of site characteristic data, with or without mean annual air temperatures. The results suggest that reliable predictions appear to be feasible without further soil temperature measurements. Elevation is the most significant local variable in the West.

Environmental Soil Science

The committee prepared an inventory of soil-related research on environmental quality and hydrology. They also reviewed soil-pollutant relationships and recommended consideration be given to developing guidelines for soil interpretations related to pesticide applications, suitability for liquid waste disposal systems, denitrification classes, and nitrogen fertilizer timing and maximum rates. They suggested that soil taxonomists should be involved in slection of representative soil sites for environmental research and that these sites be described and characterized by standard procedures.

Engineering Applications and Interpretations of Soil Surveys

A draft of a "Guidebook for Users of Soil Surveys" was prepared. This 96-page draft is incorporated in the Western Regional Conference Proceedings.

Soil Interpretations at the Higher Categroies of the Soil Classification System

The committee suggested that small-scale maps with legends at the family and higher categories are most applicable for comprehensive planning purposes. They indicated the family was the most widely used legend category and that phases of taxonomic units should be the basis for presenting interpretations. One level of taxonomy should be maintained thoughout the legend. Single values rather than ranges of values should be used in interpretations. The chief limiting characteristics should be given with use ratings and interpretive criteria should be included in the reports.

Soil Survey Procedures

Steps for proper use of published soil descriptions in preparing descriptive legends of new surveys were outlined. Use of ADP in soil survey was reviewed and continued effort on adaption to all phases of soil survey was recommended. Reconnaissance survey mapping units should be named in terms of soil taxonomy and the nomenclature should be distinct from that of detailed surveys. Standard descriptive and correlation procedures should be used for reconnaissance surveys. Ortho-photo maps should be obtained for field use where available.

Soil Family Criteria

The committee reviewed use in the West of family groupings for interpretations. Only a few examples were found and these indicated some problems of inaccurate interpretation. More testing is recommended. A total of 1591 families in the West were found to contain only one series each. Procedures for naming families by prominent series were reviewed. Most of the committee preferred using additional descriptive terminology from the taxonomic class name.

Histosols

The committee report included a tabular key and criteria for identification of higher categories of Histosols. Soil temperature data for organic soils was summarized for Alaska, California and Hawaii. Consistence terminology was reviewed and suitable terms were indicated. Standard moisture conditions to be specified for consistence determinations were suggested. Subsidence potential classes were reviewed and considered to be satisfactory except for pergelic soils where subsidence depends on the amount of ice present in the soil.

USDA FOREST SERVICE STATEMENT

O. C. Olson*

The Forest Service has been a cooperator in the National Cooperative Soil Survey for approximately 15 years. To begin my remarks I should like to review some of the things we Forest Service soil scientists have learned during that time concerning the application of soils information to National Forest Programs.

Most of what we have learned has come through trials and errors followed by adjustments and further trials. We have learned that some approaches don't work cut. At the same time we are becoming more knowledgeable about the nature of the approaches that do work out. By the term "approaches that work out", I refer to those overall information collection procedures and their outputs that communicate with the right people in such fashion that the right soils information gets into the Forest Service planning process at the right time. Those that don't work out have missed one or more of those four essential targets somewhere along the line.

Let's examine the essential targets a bit closer. First of all, the key to the whole process is the "right people" item--the planners and administrators. Going back a few years, some of the top administrators in the Forest Service began depreciating our detailed soil surveys. Rightly or wrongly, they came to believe that our going soil survey program was not really responsive to Forest Service resource management. Among other things, they were negatively impressed with the prospect of 30 to more than 100 years to complete the detailed soil survey in the various Regions at the going or foreseeable rates of progress. Perhaps equally important was that we seemed to have been projecting a" image of being unduly engrossed with classification for classification's sake.

Because hopes for an expanded soil survey program in the face of increasing budget restrictions were not realistic, we were forced to look inward. We began by analyzing the use of the existing information that we had collected. Where was it being used, how much of it was used, why was sane not used at all, how did our information mesh with the outputs of other disciplines, and so on, were some of our questions. Needless to say, we found answers but because this analyzing thing has been a continuing endeavor for several years, our understanding of causes and effects has been a gradual accomplishment. We're still working on it.

In an effort to communicate more effectively with our information users, we began by paralleling terminology used by other Forest Service divisions and adopted the term "inventory"--soil resource inventories. We placed emphasis on the need to inventory the soils as one of the resources in resource planning. Suffice it to say here that the changes has been as successful as was the change from "soil surveyor" to soil scientist. To be more responsive to critical time limitations, emphasis was given to adopting reconnaissance approaches wherever appropriate. The Regions began designing each inventory commensurate with the time allowed and the information detail scaled to the particular planning need.

. S. Forest Service, Washington, D. C.

Planning in the Forest Service as elsewhere involves making decisions. These decisions involve managing land in a wav to satisfv people's needs for goods and services, while safeguarding environment.4 values including productivitv of the land and quality of the water and air. It can be readilv recognized that decisions for land management must he made at various planning levels including (1) broad decisions for basic resource allocation and long range planning, (2) specific decisions for short term 5 to 10-year resource and development planning, and (3) detailed decisions for immediate on-the-ground action. However, the planning process is dvnamic and each level sets limits of discretion on levels below it. Because of this reason, the broadest planning should be accomplished first. Our soil resource inventories are designed to meet the non-detailed planning needs. A short time span--10 years or less--is the completion target date for several of the Regions.

The soil resource inventories have been developing me or less concurrentlv in each of the nine separate FS Regions, responding to their own set of problems, their priorities, and within limits of their capabilities. Although variations in format exist, emphasis has been given to the design of the mapping units, the "shaping" of the components within the mapping units, to the interpretations, and to getting the information into use.

Representatives of the same map unit have comparable pattern arrangements of the features by which they have been identified, differentiated, and delineated. Recognition of pattern arrangements indicates, of course, that more than a single kind or class of soil generallv occurs within a given unit, and which are recognized and defined (either narrowlv or broadlv) according to their significance to the planning objectives. In steep mountain lands, for example, where stabilitv of whole slopes is often the chief concern of management, a map unit mav include a complex of soils whose individual differences have little bearing on resource allocation decisions and little would be gained for long range planning bv recognizing several narrowlv defined soils within the map unit.

Appropriate interpretations are prepared for the mapping units and for groupings of mapping units as well as for the identified components within the mapping units. The broader the planning endeavor, the more useful we find are the interpretations applving to the entire mapping units and to the groupings of mapping units.

The fourth and final target area of emphasis concerns getting the information into use. We have learned that even though good information mav be available in a comprehensive report, this in itself is no assurance that the pertinent information will pet into the planning process. We have found without exception that upon completion of the inventorv a review of the principal facts and the management implications must be made with the responsible field officer. And without exception, we have found that continued followups are also necessarv.

We have strived to design a strong management-needs orientation into these inventories. We have given this aspect prioritv. Can we now coordinate results with the National Cooperative Soil Survev? The soils are classified, of course, hut intensive classification and description of the map units has not been an immediate major objective. Taxonomv guidelines are mainlv important to use after we have determined what the delineations should encompass and after we have determined what we want to identifv as the significant unit components. We haven't wanted taxonomv class criteria to override the flexibilitv we must have to keen maximum utilitv and the communication touches we have designed into the inventories. Rut to repeat, classification commensurate with the refinement level of the inventorv has been done and ties into the national soil taxonomv svstem. We have had several discussions at the national level concerning matters of coordination but have not reached anv solid agreement as vet.

Other areas of concern perhaps worthy of mention here include quantifying our interpretive data. Too many of our ratings are still relative to one another rather than to hard number values. We are working on portions of this problem but the answers are not easily obtained within our existing time constraints.

Next, I want to touch on our cooperative detailed soil surveys. Since the beginning of our active participation in the NCSS, we have signed cooperative work plans for more than 700 surveys and have mapped approximately 22 million acres under the associated guidelines. Our annual rate of mapping for a number of years averaged about 2 million acres but that rate is presently trending downward. For reasons already discussed, reconnaissance-type "inventories" are favored over the detailed soil surveys. I want to make clear, however, that the Forest Service supports the objectives of the cooperative program, if not all of its detailed procedures inasmuch as they apply to soils data collection on National Forest System lands for presently-used Forest Service planning purposes.

Now that we have made a strong effort to make our outputs more responsive to our users, where do we stand? We believe we have reversed a number of unfavorable trends that were developing. One indication of the possible correctness of this appraisal lies in the recruitment records. The number of soil scientists hired in the past few years have increased at a rather remarkable rate considering the personnel limitations that have been in effect. More significant, however, is the rapidly increasing number of plans into which soils information now appears; the increase of soils awareness by the line and staff people; the placing of soil scientists on more and more interdisciplinary planning teams, especially at the National Forest level which is the primary theater for resource use and development planning. These are the places where we find out if we are generally succeeding in our major objective or if we have missed the target.

This brings me to my final observation. In looking ahead there are apt to be additional changes in Forest Service planning approaches and procedures which will require on our part further adjustments or responses.

For example, there is an effort presently underway aimed at developing an ecosystem classification and mapping procedure for service-wide land data stratification. Soils will be an extremely important component of the system but not necessarily in the first format we might attempt.

In conclusion, I hope that I have made a reasonable case for the importance of flexibility. As I look at it, the use of soils information in the Forest Service has or is just crossing the threshold from haphazard, occasional uses to direct use on a planned and positive basis. Our soil inputs are getting firmly tied to the land use and resource planning system. We still have a long ways to go to make it 100 percent but I'm beginning to think that it might not be impossible to achieve afterall. However, I'm also convinced that a liberal amount of flexibility in the design for the collection and presentation of soils information will continue to be necessary to accomplish this objective.

SOIL SURVEY IN RELATION TO SOIL AND WATER RESEARCH

J. Lunin*

Soil surveys can be an extremely useful tool in translating research results into practice. It is obvious that research concepts cannot be tested on all soils, under all climatic conditions and for all crops. Basic concepts must be developed which permit extrapolation to conditions other than those under which they were conceived.

Soil properties, both physical and chemical, greatly influence soil and water management practices, and crop production. It is incumbent upon the researcher to adequately characterize the soils he is working with and to evaluate how these characteristics affect the results obtained. This is not always adequately done, however, and interpretation "f results arc limited.

The soil survey and the soil mapping unit furnishes an excellent means for categorizing soils in projecting research results beyond the specific soil used in the research project. There are some limitations, however. Perhaps the greatest limitation is soil variability. There is considerable variability within 3 given mapping unit. Some of this is readily apparent but some variability in physical and chemical properties is not. The researcher is faced with the problem of sampling to adequately describe overall, or average, conditions.

If this c R" be don", and results related to a soil type, then some extrapolation can b" made to similar soil types in other areas. If effects of physical and chemical characteristics are adequately characterized, results can be extrapolated to a wider variety "f soil types. In general, a research scientist must know not only the physical and chemical characteristics of a model profile, but the range within the mapping unit.

With the advent of emphasis on environmental quality, a new dimension has been added. We are now concerned with pollution of surface and groundwaters. Regarding the latter, knowledge of the characteristics of the surface few feet of soil is inadequate. Whether we are talking about the potential pollution of groundwater from excessive fertilization or from land application of animal and municipal wastes, we need to know the characteristics of the total body "I material between the soil surface and the water table.

Here, again. we are faced with the problem of great variability. AS an example, we arc studying th" vertical movement of nitrates in deep loess material at Trynor, Iowa, at average and high levels of fertilization. Deep cores were taken and analyzed for nitrate. The variability in results precluded any logical interpretation. A statistically designed core-sampling project was designed for just one treatment Again, results obtained were quite variable. I don't know how to overcome this. Only large differences can be significantly detected.

*USDA, Agricultural Research Service, Beltsville, Maryland

In the past, we have tried to make use of the soil classification system. One example is in the Universal Soil Loss Equation which, incidentally, is far from being universal. This equation does include a soil erodibility factor. An attempt was made to assign relative numerical values to soil types based on their susceptibility to erosion. This was not a simple problem. We had many years of record on erosion plots in different parts of the Eastern United States.

We were successful to some degree, but there were many complications. Plant cover, of course, is an important consideration. But even under fallow conditions there are some problems. The same soil type managed under good and bad conditions over a long period of time will have different erosion susceptibility, largely due to loss of organic matter and degradation of structure.

Soil erodibility is best evaluated under field conditions. Long-term natural rainfall studies were used for years to derive these values. This required many years of data to get the desired rainfall events. A field-type rainfall simulator was then constructed to hasten this process and permit evaluation of a larger number of soils. Soil variability was still a big factor to contend with, and it was impossible to have enough plots in the field to give the range of variability within a mapping unit. So, laboratory rainfall simulators were constructed. Soils could be brought from the field and samples processed more rapidly. Hopefully, this way, more soil types could be evaluated and, perhaps, even the variability within a mapping unit could be determined. It did not work for many reasons and I will not take time now to elaborate on this.

This does serve, however, to illustrate a significant point that many researchers tend to overlook in projecting research results to field application or interpretation. Once a soil is disturbed it no longer represents true field conditions. Using sieved soil in a greenhouse or in columns may provide some very useful information, but care should be exercised in projecting results to field conditions. Using lysimeters in the field or soil cores in the laboratory also have artificial boundary conditions imposed on them. Here, too, care should be taken in interpreting the results. In many instances, there is no substitute for field studies. In these cases, it is imperative that soil properties be adequately characterized and related to a mapping unit.

Studying the hydrology of agricultural watersheds involves an evaluation of all of the land characteristics and management practices that effect the movement of water over and through the land. The water retention and transmission characteristics of soils are, therefore, a very significant part of that evaluation. In the past, hydrologists have relied on gaging watersheds over a long period of years to acquire enough information to characterize the hydrology of that watershed. A major objective of these hydrological studies, however, is to develop predictive capabilities for ungaged watersheds.

This led to the development of hydrologic models. Many of these models use data from the gaged watersheds to develop their coefficients and constants to make their data fit. They were not completely applicable to ungaged watersheds. The USDA Hydrograph Laboratory is working on a model that is applicable to ungaged watersheds. This involves the use of the water retention and transmission characteristics of specific soil types. One step in this process was to evaluate these characteristics of model soil profiles of soils on our watershed research projects in various parts of the country. To my knowledge, this has been the first attempt to incorporate soil characteristics and soil survey data into hydrologic models.

We are also very much interested in using our research data in developing guidelines for recommended practices. This is especially true for problems related to environmental quality. I am concerned that if WE do not take an aggressive role in this, some agency less qualified will do it for us. I am referring now to such problems as feedlot design, land disposal of wastes, pesticide-related problems, and many others. Soil classification is an essential part of these guidelines. We have been fairly successful in developing guidelines in the area of sediment, or erosion control. We must be more aggressive in other areas.

I am aware that SCS has made great strides in classifying soils for various uses. I hope that our research scientists will keep abreast of this progress and will contribute information where possible.

The recently passed Federal Water Pollution Control Act Amendments of 1972 have stressed certain areas of concern to agriculture. Perhaps the most significant of these concerns pollution from non-point sources. An agricultural watershed is a non-point source. We are all aware that it would be almost an impossible task to try to monitor sediment, pesticides, nutrients, etc., from an agricultural area. Yet, this Act specifies that EPA, in consultation with the Secretary of Agriculture, will do research and provide guidelines for (a) identifying and evaluating the nature and extent of non-point sources of pollution, and (b) processes, procedures 2nd methods to control this pollution.

We are making considerable progress on developing practices to control pollution from agricultural operations. Identifying and evaluating these sources is a more difficult matter. As I mentioned before, a monitoring program is not feasible. A promising approach is to develop a predictive model. The problem is extremely complex, howcvcr.

First, we need a water yield model. There arc some models available, but most require some gaged data with which to adjust various constants and coefficients. I" most cases. these data are not available. Some models take into consideration only surface runoff and ignore base flow. Water yield is necessary to evaluate the contribution of dissolved pollutants such as nitrates, salts, and pesticides.

Pollutants such as phosphates and pesticides are strongly adsorbed on. and move with, sediment. Indeed, sediment itself is a major pollutant of water, Our Universal Soil Loss Equation has been most useful in predicting soil loss from a field under a given practice, we need to k""", however, what the delivery ratio, or sediment yield to the stream is. For this reason, a sediment yield model must bc developed.

Finally, the chemical aspects must be included. Various processes must bc considered for a wide variety of pollutants; solution and precipitation, sorption and desorption, volatilization, decomposition, and many others. These must be tied in with both the water yield and sediment yield models.

It is obvious that there will bc no one universal model that will encompass all aspects of the pollution problem. Several may bc required. One thing is certain, howcvcr. Every one of these models will require a soil factor. Soil characteristics not only influence the movement of water over and through the soil, but can also greatly influence the quality of the water leaving an agricultural watershed.

There may be many ways of classifying soils for use in these models. Soil survey reports, however, provide the most readily available source of information. I believe we are going to have to rely more heavily on surveys in the future. We have already made some progress in using this in our hydrologic modeling, but the effort needs to be expanded.

It would also be very helpful if adequate physical and chemical characteristics of soils were also available. It is not possible to develop data for all soil types, but some consideration should be given as to what level of grouping would be desirable as a basis for these characterizations. Much depends upon how this information is to be used.

In any case, I hope our people will work more closely with you in the future in an effort to make the most effective use of soil surveys.

EXTENSION SERVICE 1/

I appreciate the opportunity to prepare a statement to be included in the proceedings of the 1973 National Soil Survey Conference. The Extension Service has a deep interest in soil surveys and continues to strive to improve the use of the surveys by increasing the knowledge and skills of the users.

Changes and developments have occurred since the 1971 National Technical Work Planning Conference of the Cooperative Soil Survey. These affect the soil survey educational programs and activities planned and carried out by the Cooperative Extension Service jointly with the Soil Conservation Service, the Experiment Stations and others. Some of these changes and developments are:

1. More than three years ago, arrangements were made between the Extension Service and the Soil Conservation Service in Washington, D. C. to notify the State Office prior to the publication of a new soil survey report. Approximately 90 days prior to the publication of the soil survey, we notify the State Extension Specialists and the Soil Conservation Service notifies the State Conservationist. This notification provides the State and local staffs some lead time to plan educational activities in connection with the distributionand use of the new soil survey maps. data and details. We have continued to evaluate and improve this arrangement.

2. Some State Extension Services have recently employed specialists in land use. The use of soil surveys form an important base on which to conduct land use educational programs. Examples of States employing land use specialists are: Missouri and Oklahoma.

3. Recently, land use conferences or symposiums have been held. California held several over the State. I visited one city shortly after a symposium had been held and they reported a follow-up meeting had been held and much interest was shown. Iowa reported that they had their district (multi-county) agronomy specialists sttend the National Land Use Policy Conference held last November. This was followed by some in-service training of the specialists on land use.

4. More States are conducting educational programs and activities during the making of soil surveys and at the time of publication. Examples recently called to my attention include the States of Georgia and Alabama.

1/ Statement prepared by Harold I. Ovens, Agronomist and Soil Conservationist, Extension Service, U. S. Department of Agriculture, Washington, D. C., for the proceedings of the 1973 National Soil Survey Conference.

5. County and area Extension staffs are working closely with planning agencies, Soil Conservation Service and others in developing land use plans. An example of this is to be found in Wisconsin. One county has developed land use plans for a number of highway interchanges.

6. In the International Land Judging School and Contest held at Oklahoma City, non-agricultural or urban suitability factors are included as a part of the judging. This is in recognition of the need to train youth and adults on how to judge the soils' suitability for urban uses as well as for agriculture uses. This was started at the 1972 school and contest and is to be continued.

7. In recent years a number of the State Extension Services have organized on an area basis. They have area agents or specialists with multi-county responsibilities. In these cases the Extension Educational activities in connection with soil surveys are generally conducted by the area agronomy or soils agent or specialist.

8. The Cooperative Extension Service has acquired computer terminals in 18 States. These vary between States as to their intensity of operation; from one to as many as 37 in one State,

The Extension Service in Virginia has computer terminals in seven field offices. Michigan reports touch-tone telephone terminals are installed in 37 county Extension offices. I think you can see that the use of soil surveys will reach new dimensions if these computer terminals can have access to the soil survey data bank.

Recent changes and developments give increased emphasis to the importance of soil surveys in land use decisions. Cooperative educational programs and activities increase the knowledge and improves the skills of soil survey users. Developments in EDP such as computer terminals present a delivery vehicle which we should explore.

- - - - - - - -

SOIL TAXONOMY

John E. McClelland*

We have received the galley proofs for most of Soil Taxonomy, and these are being edited. At the earliest, Soil Taxonomy will be available in July. Because of the technical nature of the manuscript, it has taken a long time to check it carefully for internal consistency, context, spelling, etc. The book is appreciably longer than the 7th Approximation (1960), probably more than twice as long. It will include 12 pages of colored plates with 4 plates per page, 17 tables, 41 figures, and 130 pedon descriptions and data in addition to about 360 pages of text. The format will be similar to that of the 1960 publication. Selected chapters from Soil Taxonomy (December 1970) contains most of the major changes that appear in the edited text.

Amendments to Soil Taxonomy will be initiated by regional committees. Each of the 4 regional committees will have a chairman (Principal Soil Correlator) and 6 members, 3 selected from Experiment Station workers and 3 from the Soil Conservation Service. The members will serve for 3 years, one-third being replaced annually. Subcommittees, as needed, will be established to consider specific problems.

A national "ad hoc" committee will be formed to approve changes. Likely members are the Director of Soil Classification and Correlation, the Director of Soil Survey Investigations, the Principal Soil Correlators, one Experiment Station representative from each region, and one federal participant from an agency other than the Soil Conservation Service. The Deputy Administrator for Soil Survey will designate the chairman and members.

A soils memorandum will be prepared that will outline the policy about changes and it will have an attachment that contains procedural details. It will be circulated to the states for review. The intent is that changes will be approved by the states affected by the changes and suggestions about soils not in the United States will be approved by the "ad hoc" committee.

* Director, Soil Survey Operations Division, Soil Conservation Service, U. S. Department of Agriculture, Washington, D. C.

NACD AND THE SOIL SURVEY PROGRAM

David G. Unger*

The National Association of Conservation Districts, which represents 3,000 individual districts organized under state law to advance the cause of soil and water conservation, is intensely interested in the progress of the nation's cooperative soil survey. This is the foundation for the work of the districts in encouraging wise use of farm and ranch lands, in carrying cut sediment control programs, and in assisting with land use planning in developing areas.

A private, non-profit corporation, the NACD was organized in 1946. It is governed by the NACD Council, a body representing the *associations* of districts in the 50 states, Puerto Rico, and the Virgin Islands. Policies adopted by the Council at our annual conventions are carried out by the Board of Directors which is composed of 21 persons--three from each of the NACD geographical areas. A president, vice-president, and treasurer serve as national officers.

About 80 percent of NACD's income comes from quotas requested from the individual districts ($150 per district). State associations also contribute membership dues, and our remaining funds are derived from individual non-voting members, business contributions, government grants, and the NACD Service Department. The annual budget is in the neighborhood of $500,000.

To carry out day-by-day activities is the function of NACD's staff. Gordon Zimmerman is the executive secretary, and I am the assistant executive secretary. We are headquartered in Washington, D.C. Our other offices, and the program advisors manning them, are in New Hope, Pa. (Malcolm Crooks), Athens, Ga. (David Firor), Stevens Point, Wisc. (William Horvath), Cheyenne, Wyo. (Marvin Cronberg), and Salem, Greg. (Robert Baum). Our Service Department is in League City, Tex., and David Stewart is its manager.

There is another organization affiliated with NACD--the Conservation Districts Foundation. It prepares annual planning guide books for districts, distributes free information on districts and conservation to the public, and maintains and operates the Davis Conservation Library at League City, Tex.

NACD's activities in behalf of districts are many. The weekly Tuesday Letter serves as a communications vehicle to tie the movement together--reporting on key issues and developments and encouraging progressive action in the interests of land and water conservation. Other communications devices are our annual conventions, which include discussion forums on a variety of topics (and are the largest conservation meetings held annually in the nation), and cur seven area meetings. We also prepare special reports and railings to key individuals in the state associations of districts and state soil and water conservation agencies on a regular basis.

Our Service Department provides printing, mailing, and other services to districts at low cost. Over a million address labels are on file, and thousands of district newsletters, annual reports, and other publications are prepared there annually. They also provide promotional materials such as signs, calling cards, awards, plaques, and stickers along with jackets, caps, badges, place mats, stationery, and office supplies,

*Assistant Executive Secretary, National Association of Conservation Districts

NACD is closely associated with several important programs conducted annually with the districts of the nation. These include the Goodyear Soil and Water Conservation Awards program, designed to improve district administrative effectiveness; the newsletter contest sponsored with the Farm and Industrial Equipment Institute (over 700 districts now have regular newsletters); and the Soil Stewardship Week program. This has proven extremely popular, and millions of booklets, litanies, church programs, and associated materials are distributed each year.

NACD is also the principal participating organization in the annual National Watershed Congress. Working with us to encourage understanding and improvement of the upstream watershed program are 33 other conservation, civic, agricultural, environmental, and business organizations.

On request, NACD provides information to Congressional committees on proposed legislation and appropriations issues of concern to the conservation districts, and we maintain liaison with a host of government agencies and private organizations dealing with natural resources and the environment.

NACD also has a series of subject matter committees which meet during the year and at our convention to aid in carrying our Association policies. They cover many subjects of concern to districts such as sediment control, public lands, conservation education, youth activities, agricultural waste disposal, private forestry, land use, surface mining, shore erosion, water resources, resource planing, and soil surveys. In fact, NACD's policy calls for completion of the nation's soil survey by 1980. lhis is one of the major goals mentioned in our booklet "A Resource Agenda for the 70's."

As the times have changed, NACD has encouraged districts to keep in step with new trends and developments. We have aided in the transformation of the district as a rural erosion control agency to a broader natural resources agency, have encouraged representation of all community interests on district governing boards through general election procedures, and have assisted districts in seeking improved funding for their operations. Recently, we have been instrumental in helping them to explore the subject of mandatory sediment control legislation in the states--a direction in which half a dozen states have already provided leadership.

As we continue to develop and expand district programs, the relationship between districts and the soil science community becomes more and more important. Let me conclude by listing some of the opportunities that I see for increased cooperation.

1. We should work together to elevate the public consciousness of the need for rapid completion of the national soil survey and the importance of using soils information and interpretations in connection with land use, construction, conservation, and environmental programs of all kinds. This is a fundamental resource inventory that is essential in planning the future of this country.

2. There need to be better relationships between soil scientists and conservation districts at the local level. The soil scientist should not operate as an isolated technician but as a member of the full team of specialists assisting the district in cawing out its responsibilities. District officials should know as much as possible about the soils phases of the program of technical assistance, and soil scientists can help them learn.

3. We should cooperate in increasing the funds available from local and state sources to accelerate soil surveys to meet priority needs. At present, about $2 million is available annually for such purposes, but the amount should be greater if we are to have the information we need before decisions are made and development takes place. The key agencies at the state level in working toward this goal are the state soil and water conservation commissions. Are they fully apprized of your needs?

4. NACD needs to emphasize the issues as they relate to soil surveys. We are always pleased to receive suggested articles and photographs for the Tuesday Letter outlining new and significant developments. Not all can be used, but they can be helpful in increasing coverage of this important work.

Finally, let me say that it is evident that the role of the soil scientist will continue to expand in the decades ahead. The information that you provide, which is increasingly used in comprehensive planning, land use planning, tax assessment, land treatment, and other programs, is a valuable commodity. You and your work will increasingly be subject to pressures of all kinds, because you are helping to shape vital social and economic policies. Your objectivity and the quality of your information will be keystones in the development of many programs for the improvement of our invironment.

NACD is pleased to recognize the contribution that you are making and wishes to continue to cooperate in achieving cur mutual objectives.

Presented by J. A. Gockowski

CARTOGRAPHIC DEVELOPMENTS
NATIONAL SOIL SURVEY WORK PLANNING CONFERENCE
CHARLESTON, SOUTH CAROLINA
JANUARY 25, 1973

The Cartographic Division is, with the cooperation of state staffs, successfully carrying out its assignment regarding map compilation for the published soil survey. Many new techniques have evolved and others are being studied at the present time.

ADVANCED MAPPING SYSTEM

The Advanced Mapping System (AMS) has been designed and we are assured will be obtained when funds become available. The installation of this system will return map manuscript compilation to the Cartographic Division as it was prior to Soils Memorandum-70 (Rev. 1), dated June 19, 1970. The data from the soil survey field sheets will be digitized by automated scanning and manual digitizers to the atlas sheet format. This will result in a computer tape. By computer program this tape will be edited for errors and the conversion publication symbols will replace the field mapping symbols. A new tape will be generated, data will be displayed and a printout obtained. This printout will be edited by the cartographic staff for all the required corrections. The edit calls will be entered on an edit device (a cathode ray tube) and a new tape will be generated. This new tape will drive an automatic plotter resulting in press ready negatives. By this route, the input by the field staffs is reduced and map finishing contracting is eliminated. We look for a reduction in cost, and a reduction in the required time from map manuscript compilation to availability of the published soil survey.

MAP MANUSCRIPT COMPILATION FOR DIRECT PRINTING

In December of 1970, four areas in the country were selected for map manuscript compilation by the field for direct printing of soil maps. The criteria that the selections were based on were: (1) low intensity use area, (2) little change of land "se in future years, and (3) a relatively simple soil pattern.

The states have prepared the atlas sheets on three of the four areas for direct printing. Their work is excellent; however, on two of the three surveys, several questionable symbols were compiled that could result in an incorrect interpretation in the published survey. Consequently, we contracted for symbols and lettering guides with a map finisher. The line work that had been completed by the states will not require map finishing. The contract cost for the preparation of the lettering guides and the symbols was $4.80 less per sheet than for the complete map finishing on 5 comparable areas in the state. However, extra material, additional field compilation time in order to furnish final quality, preparing prints for lettering layout, indicate an extra input in excess of $10.00 per sheet. Consequently, we believe that the preparation of map sheets for direct printing is costing the Service more than if this work were done by a map finishing contractor.

COMBINED COMPILATION AND MAP FINISRING CONTRACTING

Wc have recently let a contract for combined soil map compilation and map finishing. The contractor will do the map manuscript compilation in a manner similar to that being done by the states. The Cartographic Division must edit the compilation and counsel with the state staffs regarding technical questions on the soil survey. Under the present procedure, there are very few technical questions since the states are answering these in their compilation.

The bid that we have received is about identical to the present cost of the state doing the compilation and Cartographic contracting for map finishing. The additional edit required by Cartographic is an additional cost. This procedure will be evaluated to determine whether it will result in a cost and total manpower reduction.

HIGH-ALTITUDE PHOTOGRAPHY FOR PROGRESSIVE SOIL SURVEYS

At the last National Soil Survey Work Planning Conference I reported on the use of high-altitude photography for atlas sheets. To date a total of 112 counties or areas have been flown and contracts were awarded on 18 areas in December 1972. The advantages arc: (1) photography is obtained in the optimum season for photointerpretation, (2) better quality mapping results through use of photobase sheets and less matching is required, (3) map manuscript compilation time is reduced, (4) quality of the photography is appreciably better since these would be first generation prints from the original negatives, even though the enlargement factor from the original film would be about 2x, (5) mapping at publication scale will allow the states to have better control of the survey making certain that cartographic detail is not excessive at publication scale.

In addition to these advantages, we have received reports by the states indicating the following: Where photobase sheets are used for progressive surveys and correlated symbols arc used for mapping, there is no problem for the local users in switching from the "field sheets" to the published soi 1 survey when the survey is published. Further, thr soil scientists, in addition to photointerpretation, can evaluate the geomorphological aspects of the terrain. This gives them additional clues in mapping and reduces the time required.

Because of the large demand for photobase sheets for progressive surveys, the Cartographic Division has procured additional equipment for the timely processing of photobase sheets for progressive surveys. The equipment is now fully operational and the time lag in delivery will be reduced.

One problem that we have encountered where photobase sheets have been prepared for progressive surveys is that some states will, on occasion, amend the work plan publication scale different from that for which the photobase sheets were prepared. This requires mosaicking of the imagery for the area and requires additional manpower. Be certain that the publication scale is determined and adhered to before you obtain photobase sheets for progressive mapping. In the last few years wc have kept track of the most often repeated questions from the states. These are:

1. Q. If soil surveys are mapped directly on photobase map sheets, will it be necessary to transfer the mapping to film transparencies at some later date?

   A. If the completed survey is suitable for publication at mapping scale as indicated in the soil survey work plan, and later date photography is not required, it will not bc necessary to recompile the photobase map sheets. However, the mapping must be delineated so that it will reproduce photographically by normal reproduction processes.

2. Q. Will the compiled photobase map sheets be the same scale over a period of months or years?

   A. The photobase map sheets may shrink or stretch depending on several factors such as amount of detail inked, age and exposure to weather. Since the photographic material is considered to be reasonably stable, any changes in scale will be corrected by photographic and other techniques by the Cartographic Division to bring it to the required scale for publication.

3. Q. What symbol book or symbols arc applicable to progressive mapping on rectified photobase map sheets?

   A. The symbols and general mapping practices outlines in the "Guide for Soil Map Compilation on Photobasc Map Sheets" arc applicable. Do not substitute symbols from other sources unless absolutely necessary. Your cartographic "nit can offer assistance in recommending symbols for unusual features when the occasion arises.

4. Q. May various color inks be used to differentiate between map features?

   A. Colored inks arc not recommended. If possible, only black ink should be used, because black is the most satisfactory ink for photo reproduction. Red-violet should be used for drainage if necessary, in extremely detailed areas. Other colors should not be used.

5. **Q.** Should roads be compiled on the map sheets and how should they be classified?

A. Roads need not be compiled. If roads are compiled they should be shown consistently throughout the survey.

All roads may be show" by solid line or classified with solid and dashed lines. Prior to submitting the completed survey to your carto unit, an up-to-date road classification map should be prepared. This map will then be used to classify the roads and trails in the survey.

6. **Q.** Should a names overlay be prepared?

A. On progressive mapping, names overlays are not required. All names should be show" on the photobase map sheet.

Occasionally, a survey area will consist of a combination of photobase map sheets partly on photographic paper and partly on film transparencies. The names overlays are not needed for the film transparencies in this case either since the remainder of the survey is compiled with the names on the rectified photobase map sheets.

7. Q. How will non-correlated soil symbols be handled if they are drafted on the photobase map sheets?

A. When the survey is complete and the correlation and classification is finalized, a soil symbol conversion legend will be prepared. The publication soil symbol will then be drafted on a" overlay that will be registered to the photobase map sheet.

8. Q. May the rectified photobase map sheets be trimmed down prior or during progressive mapping?

A. A minimum of ½ inch of photographic image beyond the neat line is required for satisfactory matching. It would be beneficial if the edges of the photobase map sheets are protected with tape.

9. **Q.** Should farmsteads, houses, schools and churches be drafted on the photobase map sheets?

A. Farmsteads and houses may be shown except in densely populated areas, subject to preference by the state.

Schools and churches should not be shown in communities over 2,500 population unless they are a landmark feature. All others should be shown.

10. Q. What are the mapping limits for each photobssc map sheet and how should they be matched?

A. Each photobase map sheet should be compiled so the detail extends across the match edge a minimum of 1/16". All adjoining photobase map sheets should be matched by viewing with a stereoscope.

11. Q. Should flow arrows be shown on drainage?

A. Flow arrows should be shown on all disconnected portions of drainage where the drain stops further than 0.15" from the adjacent drain. Flow arrows should not be show" where a drain leaves a photobase map sheet, along a drain traversing a photobase map sheet, or where a drain joins with another drain 'or body of water.

12. Q. When the survey is complete, will someone in the Cartographic Division edit the photobase map sheets before contracting for map finishing?

A. The Cartographic Division will not edit the photobase map sheets for completeness, accuracy or content prior to contracting for map finishing. Miscellaneous features such as grid ticks and some cultural features may be added by the Cartographic Division when the survey is completed.

These are a few of the problem areas most frequently questioned by state personnel. Undoubtedly, there will be others as was the case when we began our soil map compilation work in the states. Much progress has been made since that time. Most of the potential problems CR" be resolved through your cartographic unit or in consultation with the Hyattsville Cartographic Unit.

SOIL SURVEY BASES

Some state staffs, particularly in the states where the relief is excessive, are concerned about the quality of the mosaics on which the soil survey is compiled. This is particularly true in the western states where imagery from several different sources may be utilized to prepare a mosaic for a" area. For the fiscal year 1975 publication schedule and for the ensuing fiscal years we will obtain high-altitude imagery for all areas for the publication schedule, Where the relief is excessive we will lay mosaics of the new imagery. We will need to lay only about ¼ as many photos as we would lay with the regular 1:20,000 imagery. This new imagery will be available to the states for their regular Service operations. This procedure will improve the quality of mosaics and reduce manpower requirements in the Cartographic Division but will increase contract costs. we expect the total cost to the Service will be about the sane.

I" some states, orthophoto images are being used as bases for the soil survey. Orthophotos are planimetrically correct photographic images after application of photogrammetric processes. We cannot schedule needed orthophoto bases for the soil survey areas on the 3-year publication schedule because of the short time spa". The use of orthophoto imagery increases the cost of the base by 100 to 250%, depending on the amount of required ground control. Further, the flight scale of photography for orthophoto bases exceeds our 2½ diameter maximum enlargement factor to provide atlas sheets. Consequently, some resolution is lost and the quality of the imagery is poorer at the larger scale. In some areas, line base maps are used for the published soil survey. Line base maps might be used more in sectionalized country such as the midwest where location on the ground is not difficult.

REMOTE SENSING

The Soil Conservation Service is participating in remote sensing activities in the Department of Agriculture and the Federal Civil Community. We have samples displayed of ERTS-1 imagery and infrared imagery from North Dakota. This includes IR Color, IR black and white, panchromatic black and white, and four bands of ERTS imagery. At present the Service is getting a program underway for evaluation of ERTS imagery and its application to Service programs. We have selected areas in each of the SCS regions. These areas cover all program activities of the Soil Conservation Service. Training in the use of ERTS imagery is non-existent to my knowledge. The Soil Conservation Service has as well a trained group of photo interpreters as anyone. However, we must adjust our minds to comprehend the fact that on a" ERTS-1 image, we are looking at 13,000 square miles as opposed to the 4½ square miles that we are normally accustomed to viewing.

The data that can be obtained from ERTS imagery will vary appreciably from what you are presently obtaining. These data should generally be useful for making the following land use classification judgments: (1) urban and built up land, (2) agricultural land, (3) range land, (4) forest land, (5) water, (6) non-forested wetland, (7) barren land, (8) tundra, (9) permanent snow and ice fields.

You will notice when you look at the imagery that different bands will give you different information. Bands 4 and 5 show forest cover and are especially valuable for showing areas of snow cover and water born sediment. Bands 6 and 7 are excellent for delineation of drainage patterns and cropland. Working with a minimum of two bands, 5 and 7, will provide you with much more data than working with just one image. Naturally some ground truth will be required to corroborate the classification made from the use of ERTS-1 imagery.

This concludes my presentation on cartographic developments.

PROBLEMS ENCOUNTERED WITH PREPARATION OF DATA FOR THE NCSS PROGRAM

I'd like to discuss some problem areas that we can mutually resolve and thereby assist the NCSS program. These are:

1. The largest portion of author's errors on map finishing contracts are attributed to the mismatching of soil boundaries, soil symbols, and drainage between adjoining sheets. This is a serious problem since the map finishing contractor is not held responsible for matching soil lines. Correction of matching errors by Cartographic prior to map contracting has proven costly. The transparent sheets should be easier to match by overlapping adjacent sheets. A closer review of the sheets may be the answer to correct these errors.

2. Map sheets are containing soil symbols that are not listed in the alphabetical soil legend. In many instances, borrow and gravel pits are correlated and listed in the soil legend with a letter symbol but these areas are erroneously shown on the map sheets by a conventional map symbol. The compiler should eliminate both of these problems by repeatedly referring to the soil symbol conversion legend during compilation.

3. The constant problem is compiling arrows at sheet edges when the stream continues onto adjacent sheets. Do not show the arrow in this instance since it indicates the end of a stream. If drainage is continuous from sheet to sheet, the drain can extend outside the neatline which may serve to be helpful when the adjacent sheet is being compiled. Since the map finishing contractor is instructed to scribe all linework, cartographic has been paying him additional money to remove these arrows after he has scribed them.

4. Other problems with drainage

    a. Many streams are compiled with an arrow anywhere from 1/8" to 1/2" from the junction of its connection to a main stream. Ideally, all streams should connect.

    b. Improper classification of streams - In many cases, 3-dot non-crossable is shown throughout a job when 4-dot unclassified is intended.

    c. Excessive use of arrows on streams to indicate direction of flow. - In most instances drainage flow is apparent without the aid of arrows.

    d. Streams less than 1/4" in length should be omitted since they can not accommodate the dot system for classification.

5. The standard symbols listed in the "Guide to Soil Map Compilation" are being substituted for by other symbols. Compilations have been received with clay spot symbols used for erosion spots, located objects symbols for windmills and airway beacons, sand spot symbol for shallow spots of clay and ad hoc symbols for a standard mapping symbol. Symbols listed in the "Guide" are designed for the purpose of standardizing our maps and should be used unless there is a strong reason for a deviation.

6. The lettering of soil symbols has been poorly drafted. The more doubtful letters have been lower case a, d, c, r, h, n, e. Another problem has been the compilation of all capital letters in a soil area where the legend specifically requires a combination of upper and lower case letters.

7. The failure of compilers to complete two copies of the "compilation symbols sheet" - All that is required is to have each sumbol that appears at least once on the maps underlined in red on the "compilation symbols sheet". If the symbol for some reason is mapped differently than that recommended, the symbol should be added. These two sheets are important since they serve as a guide to the map contractor for defining the symbol he is required to show. Since the sheets have been inconsistent, Cartographic has to review all map sheets to determine what symbols were used.

8. The compilations of escarpments are shown in different ways. Some make no distinction between bedrock, other than bedrock, and short steep slopes.

9. **Buildings -**

   a. Large buildings are drafted to scale with no identification. If they are not identified, they should be omitted from the map sheets.

   b. Buildings are not drafted to match the complete shape of the structure.

   c. School flags and church crosses should be drafted opposite other features to prevent overlapping.

   d. We recommend that schools in cities of more than 25,000 population be omitted.

   e. Farmsteads are not being mapped consistently.

10. Failure to define pipelines and storage tanks by labeling - Cartographic must research identity and in some cases we do not have necessary material to determine; consequently, the symbols are dropped from the map.

11. Other symbols

a. Bridge symbols should be omitted.

b. Do not label water areas "water" or "w" if a dam symbol is used.

c. All symbols should be oriented in the position as defined in the "Guide".

We are receiving field sheets for scale review and encounter the following problems: (1) carto problems previously pointed out arc not being corrected on other surveys in any given state; that is, we have noted little improvement over the years. The same problems recur year after year, (2) oftentimes, the samples submitted are not representative of the survey area. It does little good for Cartographic to comment on suitability for publication scale if the examples are not representative, (3) the intended publication scale should be mentioned in the covering memorandum requesting the scale review. (4) this may require a" amendment to Soils Memo-47. The state should send in a legend of non-standard symbols they have mapped to date and non-standard symbols they intend to map later on the field sheets. At this early stage we may be able to correct the symbolization problem before the entire job is completed.

The quality of base maps for general soil maps seems to be improving but we are still getting some poor maps in areas where county highway maps are not available. If county highway or other suitable maps are not available, we recommend that the states use a two time enlargement made from the 1:250,000 series topographic maps that are available in the Cartographic Units.

WE? have been receiving many block diagrams from the text edit section for drafting. These diagrams are in the rough form from the field. The state should submit rough drafts of block diagrams to the Cartographic Unit in their servicing area so that the block diagrams are submitted to the editorial staff in Hyattsville in their completed form.

Accelerated Publication of Soil Surveys

A. A. Klingebiel*

Last year (fiscal year 1972) we sent 80 surveys to the Government Printing Office (GPO) for printing. These surveys covered about 41 million acres. For the first time in the history of the Service we published more acres than we mapped. This achievement was accomplished only after several years of careful planning, coordination of effort by many people (field, RTSC, cartographic, Information, and soil scientists) and adequate financial support. The preparation and use of a guide for preparing manuscripts, an annotated checklist for reviewers of manuscripts, special emphasis on technical reviews of manuscripts in the RTSC and Hyattsville, contract editing, map compilation in the field, and numerous cartographic improvements have all contributed to the success of the publication program.

Ninety surveys are scheduled to go to the Government Printing Office in fiscal year 1973. These are presently well in hand and we expect to send 90 this year. These 90 surveys will cover an estimated 46 million acres. This is substantially more acres than we expect to map during this same period. For the second year in a row, we have reduced drastically the backlog of unpublished soil surveys. We have plans for submitting about this same number of surveys each year until the backlog of unpublished surveys has been depleted. We now have manuscripts for about 30 surveys that are scheduled to go to GPO in 1975 and new schedules are being developed for 1976.

A summary of last year's annual state plan of operations indicates that nationally about 65 surveys will be completed annually for the next several years. At this rate, and assuming we can publish 85 to 90 surveys annually, the backlog of unpublished surveys should be zero within four years from now.

A pilot study conducted by Dr. Bartelli and his staff in the South RTSC in the use of computers in manuscript preparation shows great promise in speeding up the preparation of soil survey manuscripts. There are still some problems to work out but there is little doubt that this method will reduce time and cost of manuscript preparation. It is planned that with added experience in the Southern region, we will be able to recommend this procedure for use in the other regions.

Another procedure that should expand the use of soil survey data and speed up the preparation of soil survey manuscripts, technical guides, and special reports is the use of form SCS-Soils-5. This form and the policy for its use is described in Soils Memorandum-73 (Rev. 1), July 27, 1972.

The input of data from Soils-5 form will make it possible for authors of soil survey manuscripts to obtain interpretive data in tabular form for use in their soil survey. In addition, these data can be recalled for numerous other purposes. In addition, when the advanced mapping system is obtained in the cartographic Division so that data on soil maps and interpretations are combined and computerized, there is no limit as to the kinds of summaries and reports that can be generated for many different uses.

The demand for published soil surveys has increased greatly in recent years. Time will prove that this is one of the most valuable documents produced by the Service. Soil scientists need to support fully this effort and to help others better understand and use soil surveys.

*Director, Soil Survey Interpretations, Soil Conservation Service, h'ashington, D.C.

REVISION OF THE SOIL SURVEY MANUAL

Prepared and Presented by M. G. Cline*

Summary Prepared by F. J. Carlisle, Jr.**

Dr. Cline reviewed the procedure that was followed in preparing the drafts of the revised Manual and outlined the current status of the work. He then made some comments on what should be done now. A summary of Dr. Cline's remarks follows:

Procedures Followed

The initial plan was for Dr. Cline to revise the Manual during sabbatical leave beginning in September 1970. Work preliminary to such a revision indicated that the Manual needed to be completely rewritten, not just revised, and that the Job could not be completed in one year, as had been supposed earlier. The soil survey staff in Washington also decided that the revised Manual should not be simply a how-to-do-it document; rather, it should give the background for the standards and conventions that are presented.

A proposed outline for the revised Manual was prepared in consultation with the Washington staff. Approximately 150 copies Of the outline were sent out for review throughout the country. Minor revisions of the outline followed this review. Dr. Cline also participated In workshops in Lincoln and in Knoxville to flesh out the outline and to get an input from the state soil survey staffs. At the same time, he was in correspondence with committees of the 1971 National Soil Survey Conference that dealt with subjects pertinent to the revision of the Manual.

First drafts of several of the earlier chapters were written prior to the 1971 National Soil Survey Conference. Work on chapters 4 and 5 was delayed until after the conference so the results of proposals of 1971 committees could be incorporated into the first drafts. Most of the major changes in standards for describing soils that are presented in the revised draft of the Manual come from proposals of committees of the 1971 conference.

As the first draft of each chapter was completed, it was sent to about 50 people for review. The reviewers included members of the staff in Washington, the Regional Technical Service Centers, the Soil Survey Laboratories, representatives of the SCS state soil scientists and the Experiment Station staffs, and about 10 people In foreign countries. All comments from reviewers were transferred to a single copy of the first draft and the source of the comments was Identified. Using this procedure, all comments could be considered when the second draft was prepared. Most Of the Changes that appear in the second drafts represent the prevailing opinion or Judgment of reviewers who commented Controversial issues were resolved by Dr. Cllne.

In the summer of 1971 when Dr. Cline left Hyattsville, the following had been accomplished The first drafts of chapters 1 through 7 plus two others had been written and sent out for review. Three other chapters were in preparation by others but not quite completed. In addition, the second drafts of chapters 1, 2, and 3 had been written.

---

*Cornell University, Ithaca, New York

**Assistant Director, Soil Classification and Correlation Division, Soil Conservation Service, Hyattsville, Maryland

Status of Work Now

The following table shows the present status of work on the revision of the Soil Survey Manual:

Ch.	Title	1st Draft Sent Out for Review	2nd Draft Written	2nd Draft Sent Out for Review	Revised 2nd Draft Written
1	Character of Soil Surveys	X	X	X	X
2	Understanding Soil Landscapes	X	X	X	X
3	Preparing for Field Work	X	X	X	X
4	Characterizing Polypedons	X	X	X	X
5	Describing Pedons	X	X	X	X
6	Developing Soil Legends	X	X	X	X
7	The Mapping Process	X	X	X	
8	Investigations in Support of Soil Surveys	X	X		
9	Recording, Storing and Retrieving Data	X			
10	Maintaining Standards in Soil Surveys	X	X	X	
11	Soil Survey Interpretations	X			
12	Preparation and Distribution of Information Gained Through the Soil Survey	X			

Second drafts of the chapters indicated in the above table were sent to about 20 reviewers. Of the seven appendices, five are in first draft and one 16 in second draft. The remaining appendix cannot be prepared until the final versions of chapters 2 through 5 are approved.

The size of the revised Manual is estimated at approximately 140 pages longer than the current Manuel, which includes 503 pages (6- by 9-inch pages). If published in the larger format of the standard soil surveys, it would include about 325 printed pages. The length could he reduced a little bit through elimination of some repetition.

What Should Be Done Now

Someone located at the national office must have the responsibility for completing the work. It is not practical for one who is away from the center of national activity to coordinate the work that remains to be done.

On the whole, the response so far from individuals and offices to whom the draft chapters have been sent for review has been very disappointing. About 20 responses were received when the first chapter was sent out for review. Thereafter, the response has dwindled. No response has been received from several reviewers and offices that should be deeply concerned; some of the responses indicate only a cursory review. On the other hand, some reviewers have returned good comments that have been most useful.

The revised Manual will provide the technical standards for conducting soil surveys for the next 20 years or more. It is worthy Of attention. Substantive reviews of drafts of chapters for the revised Manual are needed now. They must come now or in the very near future or they cannot be incorporated in the revised Manual assuming that the manuscript is to be completed during the coming fiscal year.

SOIL SURVEY OPERATIONS REPORT

R. I. Dideriksen*

This report is a summary of the notes obtained from recorders assigned to the four discussion groups conference assignment on operations. Seven major items were discussed by each group, (1) kinds of soil surveys, (2) soil survey production, (3) design of soil surveys, (4) organization of soil survey information, (5) photographic bases for soil surveys, (6) NCSS map manuscript compilation, and (7) contracting map manuscript compilation.

The following report is organized by major subject matter categories. For each category, a brief background statement is given and questions considered are listed followed by a summary of the comments end recommendations of the discussion groups.

I. Kinds of Soil Surveys

The proposal has been made on occasion to eliminate the terms "detailed soil survey" and "reconnaissance soil survey" and use only the term, "soil survey". This would mea" reporting only one kind of roil survey in the progress reporting system. The intensity of the survey would be determined by scale and design of mapping units.

A. What are the advantages of using only one term, "soil survey", and what are the disadvantages?

The recorders for the discussion groups listed the following comments.

One soil survey would make time and progress reporting easier since only one activity code and progress reporting item for soil survey mapping would be used. It would promote legend design in accordance with the use planned for the soil survey rather than legend design based on kind of soil survey. Also, it would eliminate the stigma that reconnaissance soil surveys are inaccurate or inadequate.

The disadvantages of using only one term, "soil survey" are that there may be a tendency to overdesign the soil survey legend and show excessive detail in areas that can be surveyed et a low intensity or more than one intensity. This has been a problem in the past. Reporting all soil surveys as one could create doubt about the quality of all soil surveys because of the wide range in the size and kind of mapping unite and the subsequent differences in statements that could be made for one kind of soil survey. To overcome this doubt and prevent misuse of low intensity surveys, there would be a need to provide a clear statement of use possibilities for each soil survey area. One soil survey would be difficult to menage. There would be a wide range in time and cost per acre for soil surveys. Managers would have a greater tendency to incorrectly relate goals, accomplishments, and cost for one survey area that is designed to show detailed soil differences with one that is designed to show less. The acres soil surveyed may receive too much emphasis in relationship to all other activities that must be done to complete the soil survey.

*USDA, Soil Conservation Service, Washington, D. C.

B. What recommendations do you have regarding this proposal?

Discussion group C recommended that we should keep detailed and reconnaissance soil surveys as they are presently defined in the SCS field book for timekeeping and progress systems codes. They also suggested that more emphasis be placed on defining areas where reconnaissance soil surveys will provide the soil information needed and that the quality and usefulness of reconnaissance soil surveys need to be promoted.

Discussion group D recommended that we should retain the present kind of soil surveys es defined but consider using the size of the smallest delineation as pert of the name. For example, ½-acre detail, 10-acre detail. and 1000-acre detail for soil survey. Discussion group B generally agreed with the task force progress report "Guidelines for Reconnaissance Soil Surveys" dated January 22. 1973, but indicated that map scale could not he used to define the five kinds of soil surveys es some overlap of scale is necessary between kinds. Although this group favored the five kinds of soil surveys, they pointed out that the terms "detailed" end "reconnaissance" soil surveys have a definite meaning to many people.

Discussion group A recommended that the reconnaissance task force report be adopted. They suggested that a system should he developed to report all of the various five kinds of soil surveys. If this cannot be done, they indicated a preference for reporting only one kind of survey. Croup A also suggested that soil surveys should only be coded to the soil survey area.

Each group had slightly different recommendations and suggestions, but there was agreement on several important items. The recommendations suggest that all four discussion groups favored severe1 kinds of soil surveys rather than one soil survey. In addition, all groups favored a progress reporting code for each kind of soil survey. Some discussion groups distinctly questioned the use of the term "reconnaissance". No group objected to the term6 "detailed" or "exploratory" soil surveys. There were objections to identifying kinds of soil surveys by 1st, 2nd, 3rd, 4th, end 5th order because of the implication that order% or classes may infer a measure of quality to many users. One discussion group indicated that the task force 1st end 2nd order soil surveys might he detailed, high end low intensity, 3rd end 4th order might be reconnaissance. high and low intensity, end the 5th order, exploratory soil surveys.

II. Soil Survey Production

Soil survey acreage production has decreased each year for the past several years. There are many reasons for this decrease. The Administrator of the SCS has charged us to make every effort to return to the 50,000,000 acres annual production of several years ago. There are two considerations in discussing this problem, Think in terms of making soil surveys available as soon as possible to the decision makers and not in terms of merely increasing production for the records' sake. The second is that although the obvious solution is to hire more soil scientists, there is nothing to indicate that there will be any relief in budget Limitations or personnel ceilings, One of the problems then is to find ways to release the soil scientists from other duties so that a maximum amount of time may be spent on soil napping.

A. Is it practical to trein SCS people other than soil scientists to be knowledgeable of soils so that they can answer most of the requests for on-site technical assistance end if so, how could such training be accomplished?

I.11 discussion groups agreed that it is possible to train others to answer requests for on-site technical assistance. However, they felt that other specialists should not provide on-site soil assistance and soil interpretations if (1) a detailed examination is needed of a soil profile, (2) litigation may result from the investigations, and (3) unusual soils or soils that are not clearly defined need to be evaluated end interpreted.

Even though it was agreed that others could be trained to answer requests for on-site technical assistance, each group expressed a concern and had serious reservations about training others to perform professional soil scientist work. Several discussion groups stated that soil scientists should not be confined entirely to soil survey activities. Soil scientists must communicate end work with others. One group pointed out that it did not seem realistic to have good quality soil surveys and poor quality interpretations resulting from incorrect on-site evaluations of a soil.

B. How could such training be accomplished?

Three discussion groups commented on this question. Two groups suggested that a comprehensive training course in soil science should be provided et the SCS training centers. This training must include experience in soil survey field activities. Additional formal training in soils might be made a job requirement for planners. All three groups suggested that more on-the-job training be provided to others,

C. What other functions are currently performed by soil scientists that could be done by others end thus, release the soil scientists for field mapping?

Three discussion groups suggested that more biological aids be used for jobs such es: (1) mapping areas that have easily recognizable soil patterns end few kinds of soils, (2) inking and map compilation, and (3) soil mapping. Close supervision by a soil scientist is required to make this approach successful. One group suggested that others do more of the general public relations work and handle those informational meetings where only a general knowledge of soils is needed but use soil scientists when their expertise in soils is needed.

III. <u>Design of Soil Surveys</u>

A soil survey includes the mapping, classification, end correlation of the soils. The mapping units are described and characterized by both field end laboratory procedures and interpretations are made for the anticipated uses of the soil survey.

Three kinds of soil surveys are recognized, depending upon the use that is expected to be made of the soil survey information. These are detailed, reconnaissance, end exploratory soil surveys. The mapping units mainly are phases of series, soil associations end families, and phases of higher taxa in the system of soil classification, respectively, Corresponding map scales in inches per mile are approximately 2 or larger, 0.5 to 2 inches, end less than 0.5 inches, respectively.

It has been suggested that, in the design of soil surveys of wildland areas, more emphasis has been placed on kinds of land users (forestry, range, management, etc.) then on stages or levels of local lend use planning. The soil survey needs for planning extensive areas can be met with smaller inputs than will be needed to meet the anticipated needs for more intensive areas. To better guide soil survey design, can and should a hierarchy of survey purposes in terms of planning levels be developed? It is recognized that at some future date, a more detailed soil survey may be required on all or parts of the extensive areas.

A. Do we need a standardized set of soil survey design criteria for maps for defined purposes such as regions, states, counties, or parishes, end farms?

All discussion groups agreed that a standardized set of soil survey design criteria for defined purposes is not needed. Soil surveys must vary to fit the need of local users and it does not seem feasible to try and standardize the design for maps at this time. Several groups suggested that it would be helpful if examples of maps designed for various purposes and examples of general guides used in the design of manuscripts, size of areas, end difficult scales of maps were made available to the states.

B. Should the size of the soil survey area be the major design criteria?

Does planning for the same purpose in a densely populated area present the same problems as in a sparsely populated area? Are the three kinds of soil surveys that are made inadequate to meet our design needs?

Two discussion groups that interpreted the first question to relate to the design of the legend, answered "no". One group stated that both densely populated and sparsely populated areas have the same kinds of resource problems but the magnitude of the problems differs.

All discussion groups stated that present soil surveys are adequate for the designed and planned needs. The two groups who favored retaining the present three kinds of soil surveys stated that the different map scales permitted for each kind has provided adequate flexability in design. The other groups thought that the five orders or kinds more clearly defined the design of present soil surveys.

C. Should “operational planning”, “general planning”, and similar terms be defined for all uses or defined specifically for the document in which they are used?

Two discussion groups suggested that in using these terms, the intended or specific use of the soil must be defined. All groups agreed that what may be suitable for operational planning for one use may not be suitable for operational planning for another use. One group suggested that the reliability of the soil survey for planning a specific size of area might be . more useful guide for determining the kind of level of planning.

IV. organization of Soil survey **Information**

There is **continuing pressure** for additions1 **soil survey** information. **Because** financial **and** personnel resources are **limited, decisions must** be made before priorities **are assigned** to soil survey **activities.** After the **priorities are assigned,** the **soil survey** is **designed** to meet the **anticipated** needs for **soil** survey Information et **the** local. etete, and federal **levels.**

The scale of the field **sheets** for **mapping** soils should be **commensurate** with the sire of the delineationa **necessary** to meet the objectives of the **soil** survey. **When a** soil survey **is** completed. maps with **a** smaller scale then the original field sheets can be compiled. **For** example. generalized **maps can** be prepared for ell three kinds of soil **surveys.** These **maps contain** more broadly defined delineated **areas** then those on **the** field **sheets** end usually have **a** reduced scale. In **some** maps the delineated unite **are** based on **combinations** of **mapping** unite; in others. degrees of **suitability** or limitation for **single** or **multiple** purposes **are** the **bases** for the unite.

A. Should we standardize **design** criteria for **compiling** maps to be compatible with the design of the **soil** survey?

Three discussion **groups** stated that standardized **design** criteria for compiling maps **are** not needed. **One group** said **we** should. **This group** indicated **that** we **have** already **set some** general **design** criteria or et **least** guidelines for compiling **maps** in our etete-**ments** in work plane, **amendments,** end final **correlations.**

B. It **is** likely that the **"higher"** levels of **planning** will continually increase in importance **because good** planning **usually starts** at the top (the broadest) end works **down. In** many instances. **our all-**consuming interest in **the** details **has** caused **us,** in effect, to **deemphasize** equally important overviews.

can the **users** of soil survey information clearly **relate** one **level** of information to the others--either up or down?

All discussion **groups agreed** that **some** skilled **users can** relate one level of soil information to another but many **users** cannot without some **assistance.**

C. Should we have more then one level of **generalized maps** in our published soil **surveys? What specific** purposes would be served? **What** scale would you **recommend?**

All **discussion groups agreed** that more than one level of Senerelired **maps is ususally** not needed in the published **soil** survey; however, they indicated that this depends on local needs end **requests** for maps. Three discussion groups **recommended** that the kind end **scale** of **map** be determined locally since **users commonly** have different **reasons** for **organizing** end displaying **soil survey** information. One group suggested **that** if **more** then one Senerelired **map** in needed, the **scale** of **maps** requested should be shown in the soil survey work plan.

V. Photographic Bases for Progressive Soil Surveys

There are three kind. of photographic base. now available for use in progressive surveys. These are (a) photobase sheet. from high-altitude photography, (b) high-altitude photography requiring mosaicking, and (c) ASCS photography. The high-altitude photography is obtained when vegetation is at . minimum.

A. In. few orthophoto quad maps have been completed by the U.S. Geologic.1 Survey and are available. What have you found to be the advantages of each of the three photographic bases? What disadvantages? What recommendations do you have for the use of each? That is, do the advantages of one outweigh the disadvantage. in certain situations and under certain conditions?

Three discussion groups replied to these questions. Not all members of the discussion groups had experience in using all three kinds of photographic bases. Two discussion groups listed several advantages of photobase sheet. from high-altitude photography. These are (1) we can stipulate the time of flight which would display greatest soil detail, (2) less matching of soil boundaries, (3) lend use is current, (4) field sheets compile into . more finished product for special report., (5) acquaints users with photobase to be used in published survey. (6) one is able to see larger part. of the landscape, and (7) photo+... is . second generation print. The disadvantages listed were (1) there is still . delay in obtaining the photo for soil survey, (2) large sheet. are hard to handle in field, (3) difficult to stereoscope, (4) origin.1 cost is high compared to ASCS prints, (5) less contact between members of survey party, (6) the base sheet is subject to more wear and tear because of the length of time spent to soil survey one • b..t, (7) changing th. scale is costly after base map. are prepared. and (8) some haze evident in high flight..

The advantage. of orthophotography are the same as high altitude except it is used for areas where ground relief is great. The primary disadvantages are high cost and loss of stereoscopic imagery. One group listed the advantages of photobase from ASCS photos. The primary advantage is that they are readily available and prints are inexpensive. The disadvantages are (1) more sheets involved, (2) more matching, (3) distortion of photos, and (4) they are sometimes flown at the wrong time of year for the best expression of soil differences.

VI. NCSS Map Manuscript Compilation

There are recurring problems that affect the quality of compilation done in the field. These are primarily (1) matching from sheet to sheet, (2) registration of photographic images during transfer, and (3) illegible symbolization.

A. What recommendations do you have for reducing the magnitude of these problem.?

Two discussion groups recommended that most of these problem. could be overcome by (1) better quality control by the states, (2) better final checking, (3) continuous supervision and (4) more training. The other discussion groups made no comments.

VII. **Contracting Map Manuscript Compilation**

A proposal has been made that map manuscript compilation should be contracted in the non-federal sector. Adventages of this are that SCS manpower input would be reduced in the compilation, thus releasing soil scientists for soil survey activities. The disadvantage is that a technical edit will still be necessary by a soil scientist familiar with the survey. It may also require increased staff in the cartographic editing operation.

A. Whet is your reaction to contracting map compilation? Why?

Two discussion groups recommended more contract map compilation to release soil scientists for regular soil survey activities. One group did not reply to this question. One state preferred to retain some of the compilation work for training end upgrading the cartographic skills of their soil scientists. One discussion group posed the question, "Should map compilation be considered a normal pert of soil survey activities to be done by the states?" One group indicated that contract map compilation sometimes creates technical problems that are difficult to find when soil mapping units are combined end soil boundaries are not adjusting to accurately display this combination.

Comments and Suggestions on Report

W. M. Johnson - I em not sure of the recommendations in the report on kinds of soil surveys. In order to properly manage soil survey operations, we must have different kinds. We cannot compare costs, rates, end accomplishments of soil surveys in Alaska with those in other parts of the country.

R. I. Dideriksen - The replies by the discussion groups indicated that two groups favored the presently defined three kinds of soil surveys; the other two favored using the five kinds defined in the task force report. This means that all favored more than one kind of soil survey. The discussions in the operations report will be redrafted to reflect this.

A. A. Klingebiel - The intent of the question was not to limit our discussions to detailed, reconnaissance, or exploratory soil surveys. What was discussed on names for the proposed orders in the task force report?

R. I. Dideriksen - All of the discussion groups did discuss the task force report, but there were limited recorded comments on naming the orders. However, one group did indicate that the orders should be named end suggested detailed end reconnaissance of high end low intensities end exploratory surveys. Another discussion group recommended separate activity codes for the five orders.

J. D. Rourke - Group A suggested that a system be developed to keep all orders separated but we did not attempt to place names on the orders.

E. Whiteside - Group D suggested that we put the size of the acreage in the name such ½-acre detail, 10-acre detail, etc.

R. I. Dideriksen - I will incorporate this suggestion in the operations report.

G. S. Holzhey - Is the problem mainly one of bookkeeping?

A. A. Klingebiel - There would be all kinds of problems that would develop if we had only one soil survey. For example, if a soil survey of Alaska wee completed (on broad reconnaissance) it would be difficult to turn around and request money for another soil survey.

D. McCormack - We need to discuss the objectives of the soil survey. This would guide us on the kinds of surveys needed.

E. Whiteside - We need to further study the report of the Reconnaissance Task Force,

W. M. Johnson - This will be done. The report was a draft. I would like to emphasize again that management makes it imperative to distinguish between soil surveys where production varies from 1,000,000 acres per man-year to 20,000 acres per man-year. As Klingebial pointed out, once you report the soil survey is complete, it is very difficult to Set money to make a more detailed soil survey.

I., Bartelli - I move that we accept the report of the Reconnaissance Task Force and include it in the operations report.

The move was recorded and passed by the conference members.

R. Huff - Can we accept task force report before accepting operations committee report?

M. Cline - Acceptance will mean endorsement by many.

W. M. Johnson - It should not. We are accepting a draft to be included in the proceedings.

R. I. Dideriksen - I move that the operations report, with additions, including the task force report be accepted.

The move was seconded and passed by the conference members. (See Attachment 1, Progress Report, Task Force for Guidelines for Reconnaissance Soil Surveys.)

Recorders: Robert Johnson, Keith Schmude, Darrell Gallup, Robert Wells

Reporter : Ray Dideriksen

SOIL SURVEY INTERPRETATIONS

Keith K. Young*

I. Engineering Applications

A. The new national form (SCS-Soils-S) for recording and placing in the computer soil survey interpretations has been available for use in the field for five months. Definitions and instructions for completing the form are printed on one side of the form.

Question. What kinds of problems have you encountered in using the form? What specific suggestions do you have for improving the definitions, criteria, procedures, or the form itself?

Response. There is lack of space to get all phases completely characterized. There may be trouble with a small percentage of soils--may have to compromise on a few soils. Problems seem to be within the recreational uses and daily cover for landfill when soil has many surface textural phases--also soils that cross several PE lines. Practice will be needed to fit all phases to interpretation records. The RTSC's are learning how to do this. We have been able to handle all situations so far.

A supplement to the instructions is forthcoming, summarizing results of Soils-5 meetings in three regions.

Time must be scheduled for review of interpretation records. Computers are programmed to help on the review of engineering properties. All disciplines in the state and RTSC must be involved in the development and review of interpretations.

Review procedure (Soils Memorandum-11) requires that 36 copies of the review draft be sent to the RTSC. The cost of reproducing these large forms is high, and less than 36 are needed by the RTSC. The RTSC should be free to determine the "umber they should require from the states.

B. Some soil limitations are more difficult to overcome than others. Some soils have severe limitations that are so difficult or costly to remove or to modify that users must either decide to live with the problem or select another site.

Question. How can we best show users the differences in soil limitations where vast areas are rated as having severe limitations but important differences in difficulty and cost of modifying or overcoming the limitation exist?

Response. The kinds of restrictions that cause a soil to be rated severe must be indicated. We also need to indicate how users can overcome the severe limitation. (Specific design criteria should be avoided). Some way of showing potential development or development difficulty should be tried. Costs of development or cost index are difficult to establish except on a very local basis. Outside expertise should be used to establish these costs.

*USDA, Soil Conservation Service, Washington, D.C.

C. Soil ratings for non-farm uses are made in terms of slight, moderate, and severe soil limitations. In some instances, people must use soils that are rated as having a moderate or severe limitation. To bc most helpful to these people, we need to be able to tell them why the soil has a moderate or severe limitation and in general what can be done, if anything. to reduce or remove the limitation. It is not the intent that we present design criteria but we should know what practices have been successful and about what they cost. One example would be that a cement slab for a house on soil "X" requires reinforcing steel costing about "Y" amount of dollars. It is the intent that this information be in technical guides and not in published soil surveys.

Question. What is your reaction to the Service developing this kind of information for use in technical guides so that more specific information can be given to map users? How do you suggest we go about gathering these kinds of data and how should they be presented?

Response. Yes, cost data for overcoming limitations should be assembled for use in technical guides. Encourage local experts to help develop cost or relative index information for overcoming limitations. Other agencies, ARS, FHA, experiment stations, should help develop this information.

D. Numerous soil interpretations we make are influenced by the kind of soil material that occurs below the normal depth we investigate the soil to classify it. One common example is interpretations for sanitary landfills. It is important that we alert users about the depth we normally study and evaluate soils but we should provide information on the soil materials to depths of 5 or 6 feet or more even if it is not needed for classifying the soil.

Question. How can we improve our interpretations for soil uses that are influenced by soil materials below about 5 feet from the surface?

Response. We can improve interpretations for soil uses that are influenced by soil material below 5 feet by working closer with geologists in developing interpretations of soils. Soil scientists should be encouraged to use all lines of evidence to determine the material below 5 feet including occasional deep observations.

E. The new Guide for Interpreting Engineering Uses of Soils has been in the field for about a year. One of the new interpretations included in this guide for the first time was criteria for estimating potential frost action. As these criteria are not completely satisfactory, new criteria have been developed. These criteria will be distributed to participants of the National Conference before January 1973.

Question. Are the new criteria satisfactory? If not, what changes need to be made?

Response. The new criteria for frost action is "at entirely satisfactory everywhere for several reasons:

1. The amount of soil moisture in a soil profile of Xeric soils available during the winter months for freezing in many instances is as great, or greater, than Udic soils.

2. Variable diurnal fluctuations of temperature are common to many intermountain areas and adjacent coastal states.

3. Certain temperature regimes with narrow fluctuations between maximum and minimum temperatures may not freeze. An example is in Mesic temperature regimes on the West Coast.

Several suggestions for improvement of the criteria have been submitted for consideration. One suggestion, based on soil texture,families, includes soils of Xeric moisture regime with Udic soils; and refinement of temperature classes.

We will work with some experts in the field to improve the guide. We will send another draft out for review.

II. Soil Interpretations at the Higher Categories of Soil Taxonomy.

In accepting the report of the national committee on soil interpretations at the higher categories of soil taxonomy, the 1971 National Committee directed the committee to reorient its activities. For this reason, the following discussion is directed to the making of interpretations for general soil maps, regardless of the categoric level at which the mapping units might be defined.

A. The new soil classification system provides for interpretations at each of the categorical levels. Although the interpretation potential is best at the series level, it is still good at the higher categories. There is need to explore and take advantage of the opportunities the new system can provide us.

question. What examples do we have or what should we do to explore the potentials of the new classification system as it relates to soil survey interpretations?

Response. Several examples of how interpretations have been made at various levels of the classification system are as follows:

Soils of the Great Plains -- phases of associations of great groups
Nevada -- phases of family
Mississippi Delta -- phases of great groups

Explore potential of new classification system as it relates to soil survey interpretations by testing interpretations by like families. Use interpretation data system to help make these evaluations.

B. Interpretations presently being made for general soil maps are for the taxonomic units comprising a given mapping unit. 0" some landscapes, the patter" of occurrence of soils with severe limitations could have a significant effect on a contemplated development on that landscape. 0" other landscapes with a patter" of soils with slight limitations and soils with moderate limitations, development on the soils with slight limitations could have a" unfavorable effect o" the soils with moderate limitations; e.g.. the lateral movement of sewage effluent from the soil with slight limitations for on-site disposal into the one with moderate limitations because of wetness could change what was a moderate limitation to a severe limitation.

Question. Should we consider incorporating into the descriptions of the mapping units for small-scale maps a" explanation of the geographic relationships and a" overall evaluation of that mapping unit in addition to the interpretations of the taxonomic components?

Response. We need to stress geographic relationship and potentials of each component in the association. Use block diagrams to show this relationship.

Discussion from floor. Bartelli--Need to give overall rating for mapping unit.

C. Question. What suggestions do you have for presenting both the overall rating for a mapping unit and interpretations for each component (taxonomic unit) of the mapping unit?

Response. Most users will want a summary racing for a mapping unit. Many acceptable methods have been devised to show these, e.g., pie charts, percentage slight, moderate or severe, etc. Block diagrams are useful to show relationships of one soil to another on the landscape.

Discussion from floor. Johnson--The use of percentages in the "pie" charts could be misleading to the user if he does not understand the principal used to prepare the rating.

D. The demand is increasing from within-state regional planning groups for a small-scale map of about 1 inch equals one mile for use in regional planning. These maps are larger and have mare detail on them than the foldout general soil maps, mostly 3 miles = 1 inch, used in published soil surveys. The map scale and the cartographic detail at 1 mile = 1 inch more nearly meets the needs of regional planners.

Question. Should we consider publishing a 1" = 1 mile scale general soil map as part of the published soil survey in areas of rapid development and growth? If so, what kind of legend should wc have and how should the interpretations be related to the printed text?

Response. Many survey areas need a map of 1/2 to 1 inch/mile in areas of rapid development. These can be published in a survey or a few copies can be made for users. Interpretive maps can be prepared by computer (MIADS, SPIT).

E. Planners and others who use several kinds of maps find that having their source maps on the same scale is a great convenience. Also, many planners develop their own maps at unique scales, and to have source maps at these scales is a convenience too.

Question. To what extent, if any, should soil map scales be adjusted to match scales of other important existing maps that planners "se or to scales of maps that planners themselves develop and then use?

Response. We should select the scales that we feel are significant to show the detail necessary for the survey and publish on standard scales. Slight adjustments in scale to accommodate users would be okay, but enlargement much above the scale at which the map was made is hazardous. Consideration needs to be given to a policy on enlarging maps much beyond the scale at which they were mapped,

F. The general soil map and the accompanying text are included in published soil surveys to introduce the reader to the soils of the area by giving a broad overview of the general location and extent of the major kinds of soil including their limitations and potentials for use.

Question. Does this section in the published soil survey serve the intended use? Are there better ways of introducing the reader to the soils of a" area? What kinds of interpretations should be included with the general soil map?

Response. For a general overview, yes. the general soil map serves that purpose. However, more detail is needed for some planning purposes. In these instances, larger scale maps should be included in the manuscript, put in a folder in the publication. Interpretations could also be included of the general soil map.

No ideas were presented by the committee on better ways to introduce readers to the sails of a" area.

Interpretations must be general and broad -- more detailed interpretations are given elsewhere.

G. Some soil scientists suggest that we incorporate more information on geology and geomorphalogy in that section of published soil surveys that accompanies the general soil map. This would relate more closely the geology of the area with the soil survey and provide greater opportunities for making interpretations especially useful of construction and sanitary engineers.

Question. What are your thoughts on this matter? Provide some specific examples on how this suggestion can be done or present basic reasons for not carrying it out.

Response. Encourage, for example, state geological survey, SCS geologists, or geomorphologists to help prepare a section on geology for use in the soil survey manuscript. The section must be a" authoritative dissertation and tied to soils.

III. Handling Soil Survey Data (ADP).

A. The national committee on Handling Soil Survey Data in 1969 and again in 1971 recognized the need for some kind of procedure, or clearinghouse, to deal with this problem. Due to other high priority work and constraints on both funds and personnel ceilings, no solution to this problem has been developed. While the problem is relevant to all soil data subsystems, it is especially important to the Pedon Data Subsystem and the Soil Interpretation Subsystem. State universities, especially in their graduate programs, generate comprehensive sets of data on many soils; and greater use of such data will be possible if they can be put into a national data bank and stored according to a standard format so that other investigators can retrieve and use the data with ease.

Question. What kind of procedure (or clearinghouse) should be established so as:

1. To make easy and convenient the exchange or sharing of data in the soil data bank?
2. To know what relevant computer programs have been written, tested, and are available?
3. To update national codes and formats for data in storage?
4. To decide what data will be stored. including both kind and quality of data?

Response. The Pedon Data Subsystem is now developed. Data should be cleared through the RTSC's. Someome from SCS at the national level should be authorized time and equipment to work with NCSS committee in getting the program in operation. Montana, North Dakota, and Minnesota have been using pedon data system with success. An inventory should be made in each region of the kinds of programs being used and what has been accomplished.

Minimum amounts and kinds of data need to be set. Explore the use of mark sensing cards for pedon descriptions. Make sure the terms in the manual and data subsystem are the same.

Discussion from floor. Bartelli--Mark sensing cards are to be used by SCS laboratories for use on a trial basis. Klingebiel--I recommend that mark sensing cards and Decker's thesis be routed to all concerned. Johnson--We need to consider use of a system used by USGS, a small card punch device that can be used in the field.

B. By inputting is meant the transfer of data from an external source to an ADP data bank, and for most soil survey data two steps are necessary. The first is the preparation of data, including coding if necessary or the filling out of forms like Soils-5; the second is card punching or whatever method is used to transfer the data to the ADP bank. Even with detailed instructions for these steps, some training and practice will be necessary for any office to do one or both of these tasks.

Question. Should the actual inputting of the data, at least within the SCS, be concentrated at certain offices, such as the RTSC's and the Soil Survey Laboratories, or should state offices be encouraged to acquire the capability too?

Response. Where the data is to be entered depends on the amount of data to be entered. If a state has much data to input, they should be trained to do the job if they can handle it. Most data should be entered on a form by the office originating the data. Keypunching generally should be done by ADP units.

C. ADP, like spades and augers, is intended to be used wherever and whenever appropriate to help in making soil surveys and handling data that are thereby accumulated.

Question. What can or should be done to encourage full participation by NCSS members in the soil survey data bank?

Response. Information and educational programs to show what has been done, what can be done, and how to get started.

D. "Garbage in, garbage out," is a common saying among ADP people. The question of quality control is both sensitive and important.

Question. How can adequate quality control be implemented and maintained so as to avoid cluttering the soil data bank with data of low quality?

Response. Develop and maintain minimum standards. Control through clearinghouse.

E. In the course of field work, one, or perhaps two or three, laboratory determinations may be made. For example, laboratory texture checks but no other determinations may be made on selected soils. If such fragmentary data are accepted far the soil data bank, we will accumulate many ADP computer records with very few data in them.

Question. What should be the minimum data requirement to qualify for acceptance into the soil data bank?

Response. At the time of final correlation, make a determination as to whether the data at hand is adequate to qualify for acceptance into permanent storage.

Another viewpoint is to develop a list for future review by regional work planning conferences.

IV. Environmental Soil Science.

A. In recent years. much attention has been given to the recycling of human and animal wastes using the soil as a medium for depositing these materials. Numerous methods are being tried for spreading these wastes on and in the soil. Experience shows that some of the factors that influence the results of this method of waste disposal are (1) the kind of soil, (2) the climate, (3) the management program followed, and (4) the nature and composition of the waste material. Soil scientists have a major contribution to make in the development of adequate and safe waste disposal systems as they relate to different kinds of soil.

1. Question.

a. How can soil scientists work more closely with those doing research on waste management so that the results can be applied to kinds of soil?

b. How can we encourage those responsible for waste management research to carry out studies that will help us make predictions about soil behavior for benchmark soils?

Response.

a. We must become familiar with personnel in those disciplines in ARS, universities, and others that are conducting research on waste management. These disciplines might include microbiologists, soil physicists, geologists, soil chemists, and others. In this manner we will be able to make some input into research projects that are to be conducted and where. We must get involved.

b. We must acquaint those persons conducting research with our capabilities pertaining to predicting soil behavior and extending this information to other areas. Researchers are not aware of our capabilities in many instances. We should encourage research on benchmark soils.

2. Question. How can soil scientists become better informed on current research on waste disposal and management?

Response. The only way we can become acquainted and better informed on current research on waste disposal and management is through reading. The Washington office should make available abstracts and reading lists that apply to specific subject matter areas.

3. question. What field trials, observations, or evaluations can or should a field soil scientist do to improve his knowledge about soils and waste disposal as he performs his normal functions in making and interpreting soil surveys?

Response. The field soil scientist should not become involved in conducting field trials on his own, but should assist where needed in identifying soils in trial areas. Observations and evaluation of the results should be well documented in his field notes. During the normal functions of field mapping, notes and evaluations of problem areas should be recorded when such areas are encountered. This information will be most useful in making and interpreting soil surveys.

4. question. How can we improve our knowledge about the behavior of those soil properties that are most influential in affecting waste management practices?

Response. We must analyze data recorded in current literature about specific waste management practices in order to define those soil properties that are most influential. Once these soil properties are identified, the information and guides should be dissiminated to the field.

B. Much attention has been given to the use of chemical fertilizers 0" farms and its influence on water quality. Evidence is available to show that in some places the use of excessive amounts of fertilizer, poor soil selection, and the use of poor soil management practices has resulted in an increase in the amount of nutrients in water supplies.

Question. Can or should we develop guidelines for maximum safe rates and schedules for use of fertilizers as related to kinds of soil, crops to be grown, and management practices to be followed? How can we encourage meaningful research on these problems?

Response. We should not shy away from the development of guidelines of research programs. However, we are not in a position to take an active leadership role -- only advisory.

C. Little effort has been expended on studying the interaction of pesticides with defined ranges in soil properties. Adsorption of herbicides seems to be controlled by moisture content, kind and amount of clay, and organic matter content of the soil. Adsorption is much higher on air-dry soil samples, also it increases as organic matter content increases. Studies have shown no consistent effects from other soil properties. This may be due to the character of the studies; most have included only a limited range of soil conditions. Very few have included studies of soil taxonomic units. It should be possible to make recommendations for rates and frequencies of herbicide applications and take into account the differences in the effectiveness and persistence of herbicides on various soils. This would minimize the pollution hazard.

Question. What factors can be used to develop guidelines for rates and timing of herbicide application for phases of soil series?

Response. Much research is being conducted on rates and timing of herbicide application. The problem is to evaluate the results of those independent projects and relate them to soil series and phases. A study of the sail properties and qualities of these soil series may result in the establishment of factors that can be used to develop guidelines for rates and timing of herbicide applications. The problem becomes more complex because decomposition products are more toxic than original material. This may require a general grouping of soils as to their capability to accept herbicides and disperse the by-products.

D. The guides we are now using to determine soil limitations for use as sanitary landfills were designed to evaluate the soil to a depth of six feet. The main use for this guide is to help soil scientists evaluate named kinds of soil for potential landfill sites. The evaluations relate largely to workability of the soil, soil permeability, soil depth to water tables, rock or impervious materials, flooding and soil slope. Soil limitation ratings for this use are designed to help people, through the use of a soil map, locate soil areas that have soil properties favorable for use as landfills. They, of course, would also show soil areas that would be least favorable for a landfill. It has been assumed that geologists, engineers, and others would make on-site evaluations for the selection of a specific site for a sanitary landfill.

Question Can and should we work more closely with geologists and sanitarians in relating kinds of soil in a survey area to the underlying materials so that more specific guidance can be give" to individual kinds of soil regarding hazards of underground water pollution?

Response. We recommend working more closely with geologists and sanitarians primarily to acquaint them with our capabilities and expertise. In this manner, more specific guidance can be give" to individual soils and like soils regarding hazards of underground pollution.

Discussion from floor.

Should soil surveys be used in design?

They are being used for design at least in a general way. This seems to be a legitimate use of soil surveys.

Johnson--Soil conditions are used to influence design of structures. We need to influence the engineer to design to overcome the soil problem.

Bartelli--Soil surveys are used as design criteria in New Orleans. They are used to determine length of friction piling required for house foundations in the marsh areas.

Grossman--Penalty points could be assigned properties that adversely affect a particular use.

Should cost data be included in published soil surveys?

No.

SOIL CLASSIFICATION AND CORRELATION REPORT

Frank J. Carlisle, Jr.*

This report follows closely the outline of discussion questions on this general subject that was distributed in September 1972 to the expected participants in the conference. It is based largely on notes of the recorders for this subject for each discussion group, namely, R. C. Huff L. I. Harmon, G. J. Latshaw, and J. C. Powell. The report is organized as follow. Statements of each topic and of the related discussion questions are followed in turn by a synopsis of the response of the discussion groups. Notes on the discussion at the plenary session of the conference appear at the end of the report.

A. Application of Soil Taxonomy

Problems have been reported in applying present definitions of Aquents, Aquepts, and Aquolls. Part of the problems have been in distinguishing the soils of each of thr three suborders from other suborders in the same order. Part of the problems have been in distinguishing soils of the three suborders from one another, especially Aquents from Aquepts and Aquepts from Aquolls. There has been considerable uncertainty about the proper placements of series into the great groups of Haplaquolls and Humaquepts. There has been similar uncertainty about placement of series into the great groups of Haplaquents and Haplaquepts.

A.1. Question. Are the problems due to deficiencies in criteria which might be corrected? If so, how might this be done?

A.2. Question Are the problems due to the difficulties in application of the criteria?

A.3. Question. Can soil drainage classes as those have been recognized 'be helpful in distinguishing these suborders or their great groups and subgroups?

Distinguishing fluventic subgroups of Ochrepts from some other kinds of Ochrepts and from Fluvents has posed problems. A given pedon may be classified in on:: subgroup by one person and in another subgroup by a second. If a soil is to be an Ochrept, fine bedding or Stratification must be absent to a depth which allows a cambic horizon to be present. What remains as a basis for distinguishing fluventic subgroups from other Ochrepts for all practical purposes is then the organic matter distribution in the profile, This has not worked well for field estimates.

Differentiation of fluventic subgroups of Ochrepts from Fluvents rests on lack of a cambic horizon in the latter. The lack must be established by identification of fine bedding or stratification and irregular vertical distribution of organic matter. The identification of these two features has teen ""certain. Soils formed in alluvium have been classified as Fluvents at one time and as fluventic subgroups of Ochrepts at another time.

---

*Assistant Director, Soil Classification and Correlation Division, Soil Conservation Service, Hyattsville, Maryland

It has been proposed that flooding be used as a basis for identification of fluventic subgroups. They would share flooding as one characteristic with Fluvents. It has also been proposed that fluventic subgroups of Ochrepts be dropped from the system and that such soils be included in the parallel subgroups of Fluvents instead.

A.4. Question. Should fluventic subgroups be dropped from the suborder of Ochrepts?

A.5. Question. Should flooding be introduced as criterion for fluventic subgroups of Ochrepts?

Responses to questions A.1., A.2., and A.3.

Three of the discussion groups responded to these questions.

(a) They agreed that the problems are due to difficulties in application of the criteria.

(b) One group (D) thought the present criteria are good enough that they should not be modified ""less it could be established that a change would allow a marked reduction in the present problems in application of the criteria.

(c) Two groups (B and C) suggested that an effort should be made to sharpen the definition of the lower limit in degree of expression of cambic horizon.

(d) One group (C) suggested that requiring a minimum thickness of the mollic epipedon of 10 inches for Aquolls would reduce part of the problem. This is related to the problem of determining the thickness of the cambic horizon in Humaquepts and Haplaquolls.

(e) The three groups that responded were agreed that the soil drainage classes are not helpful and cannot be used to differentiate among these classes.

Responses to question A.4.

These questions are concerned with the distinction of fluventic subgroups of Ochrepts from some other kinds of Ochrepts and from Fluvents. The problems are in part similar to the ones considered for the aquic suborders and greet groups in that they involve the criteria for the minimum degree of expression of the cambic horizon and the amount and distribution of organic matter with depth in the soil. Again, three of the discussion groups considered these questions.

(a) None of the three groups recommended that the fluventic subgroups be dropped. T.o advised explicitly that the fluventic subgroups should not be dropped. It was thought these subgroups will be useful for interpretations made for classes in the subgroup category and that these subgroups seemed useful enough to justify further testing rather than dropping them now.

(b) One group (B) repeated a suggestion that an effort should be made to sharpen the criteria for the lower limit in degree of expression of the cambic horizon and to teat the possibility of making the definition slightly more restrictive in that respect. One possible criterion that might work in this direction would be to require peds distinct enough that crushing them results in a perceptible change of color.

Response to question A.5.

The three discussion groups responding were agreed that flooding should not be used as a criterion. Two reasons given were that the criterion would be difficult to apply and we commonly would lack the data that would be needed.

B. Water Table - Drainage Classes

A set of four water table-drainage classes was proposed for discussion by the Western Regional Conference. The objective was to improve the present bases for placement of soils into certain suborders, greet groups, and subgroups. Problems were anticipated in such a" approach, but it was still believed that some gains might follow. The proposed set of classes is as follows:

Extremely wet - saturated more than 10 months of the year within 20 inches of the surface.

Very vet - saturated 6 to 10 months of the year within 20 inches of the surface.

Moderately vet - saturated 3 to 6 months of the year within 20 inches of the surface.

Slightly wet - saturated less tiian 3 months of the year within 20 inches of the surface.

B.1. Question. Can classes for natural soil drainage be related to the water table-drainage classes?

B.2. Question. Should tine proposed classes be tested across the country with a view to possible adoption for characterizing soils?

Response to question B.1.

All four of the discussion groups agreed that the water table-drainage classes, as proposed, cannot be related to the soil drainage classes generally. The proposed classes seemingly would be useful for some soils in some areas; for example, it was Indicated that they relate well to some water table studies that have been conducted in Pennsylvania and Maryland. But they do not relate well to natural soil drainage classes in several parts of the country. Individual soil series would cover two or three of the proposed classes in some instances that were cited.

Responses to question B.2.

(a) Recommendations on this point varied but three groups (A, B, and D) clearly recommended that they should not be tested across the country because it is already known they will not work in at least part of the country. One group (C) recommended that, with needed modifications, the proposed classes should be tested.

(b) One discussion group (B) recommended that the water table depth and duration classes proposed by the Northeast Region in 1968 and that were included in the report of the 1969 National Soil Survey Conference should be tested in other parts of the country. The proposal was for testing Of those classes against existing data on water table depth and duration to evaluate usefulness of the classes and to seek suggestions as to how they could be made more useful.

(c) One discussion group (A) suggested that the natural soil drainage classes and proposals for water table depth and duration classes be dropped. They suggested instead that water table depth and duration criteria should be built into the class definitions in the soil classification system. A second part of their suggestion was that soil surveys should include descriptions of water table depth and duration for kinds of soil rather than to indicate those features by a set of classes.

(d) In contrast to the suggestion in item (c) above, discussion group (D) emphasized that the water table-drainage classes should not te used to place soils into suborders, great groups, or subgroups. At the same time, they indicated that in making this recommendation they did not wish to discourage the study of rater tables and, presumably, the study of ways to characterize water tables in soils.

(e) Although some of the discussion groups seemed to differ sharply in some of their views on water table classes, it is evident from the notes that all of them considered information on water table depth and duration to be important, especially for interpretations of soil surveys

(f) Two other comments should go into the record for consideration when further attention is given to characterizing water table depth and duration. One suggestion was to try for three classes that would be compatible with wetness classes used in the legend of the FAO map of North America. A second was that the set of water table classes in the current Guide for Engineering Interpretations of Soils should not be overlooked

C. Construction of Mapping Legends

Questions about the design of mapping units have come up in regional work planning conferences. These apply especially to range and forest lands in the western states and to forest lands in the northeastern states. Questions have not been restricted to range and forest lands or to the two parts of tbe country.

The construction of a mapping legend for a survey entails preliminary classification of the soils of the area at some level. It also entails an accommodation between a classification system and the segments of the soil mantle to be show as delineations on the maps. The classification system in current "se, the prior knowledge of soils in the area are used in construction of a mapping legend. It in turn is a preliminary correlation of soils of the given area with those of other localities.

C.1. Question. What should be the detailed procedure in construction of the mapping legend for a survey? Should the procedure differ among kinds of surveys7

C.2. Question. Should transects be made to identify kinds of soil and provide some idea of their patterns of occurrence as well as their extent prior to construction of a mapping legend?

C.3. Question. Do taxadjuncts serve adequately for the recognition of naturally occurring kinds of soil that overlap or cross taxonomic boundaries imposed by higher categoric Levels of the current system?

C.4. question. Do you have any ideas for improving the accommodation between the taxonomy and naturally occurring soil bodies?

Responses to questions C.l. and C.2.

(a) The four discussion groups seemed to agree that the general procedure in construction of the mapping legend should not differ among kinds of surveys; although, one group (C) indicated that details of the procedure would vary depending on what was already know" about the soils in the area.

(b) One group (E) did not discus6 these questions at length, suggesting that the discussions in the draft of the revised Manual seemed adequate.

(c) One group (D) prepared a general outline of the procedures to use in construction of the mapping legend. The outline is as follows:

1. Define the objectives of the survey.

2. Identify the kinds of units that can be recognized and mapped. Decide the size of individual bodies of contrasting soils that can be and need to be separated to meet the objectives of the survey.

3. Determine by some technique (such as trarisects) the components of the bodies and the percentages of each major component. (This presumably refers to sample bodies that can be delineated.) It is important that this information be obtained before establishing the mapping legend so that the legend will meet the objectives of the survey and will fit the landscape.

4. Describe and classify each component.

5 At the end of the first year of mapping, sample what has been mapped, using some planned method, such as transects. The" revise the legend on the basis of the information obtained.

The preceding outline seems consistent with comments made by the other discussion groups. Several comments emphasized that prospective users of the survey should be involved in decision8 about the kinds of mapping units and the size of delineations that would be needed for the objectives of the survey.

Responses to question c.3.

(a) The three discussion groups that commented answered the question affirmatively.

(b) One question was raised about the use of the taxadjunct to handle one phase of a series when several phases of that series are in one legend and only the one phase lies outside of the defined range of the series. Such usage appears to be precluded by the definitions of phase and of taxadjunct. On the other hand, that "sage is thought to be common in some situations, particularly in naming eroded soils. The question was not discussed.

(c) Group (D) suggested that a record of the nature, location, and extent of soils handled as taxadjuncts should be kept for future use in the development of series classes.

Responses to question C.4.

The following suggestions were offered by one or the other of two discussion groups:

(a) The defined ranges of series should be expanded, wherethat is possible, to include unnamed soils.

(b) Limit the definitive range of each series to those characteristics that are needed to set the series apart from its competitors.

(c) Make transects of delineations of major mapping units to determine how well the taxa for which the soils are named fit the soil bodies. Unless such information is gathered, one does not know how well the taxonomy fits the soil bodies. This would be a first step in improving the accommodation between the two.

(d) The taxonomic name of the family to which each series belongs should be apart of the initial legend for each survey. This should help to assess the degree of accommodation between taxa and soil bodies.

D. Definition of Phase

The definition of the phase in the Soil Survey Manual allows it to be subdivision of any class but not a category in the classification system. The basis for subdivision may be any characteristic or combination of characteristics significant to use or management Of soils. Soil phases shown on maps are for the most part named as and consist predominantly of soils within one series.

Phase separations in each survey area have been designed to provide the kind of information needed in that area. Thus, permissible spans within phase6 have bee" narrower in some surveys than in others for the same kind6 of phases.

The nature of phases and the spans allowed within them become important to the single sheet interpretations for soil series and to the use of computers in assembling survey interpretations.

D.l. Question. Is the existing definition of the phase as a subdivision Of series or of other classes still acceptable?

D.2. Question. If the present definition seems inadequate, do you have suggestions for modification to make it more useful?

Responses to question D.l.

Three "f the discussion groups answered the question affirmatively. The fourth group did not give a yes or no answer to the question, but their comments indicate that their combined judgment did not differ greatly from the one reached by the other discussion groups. The summary comments of the fourth group (D) follow:

> We recognize that there would be merit in defining phases as taxonomic classes so that the computer could be used to print out interpretive data. The group, however, does not wish to give up the flexibility that we now have in using phases to meet the local needs for interpretations just to accommodate or facilitate "se of automatic data processing methods. A second consideration is that if phases of series were made taxonomic classes, the number of such taxonomic classes would be unwieldy.

Recorded comments from other discussion groups were related to question D.l.

(a) Croup (A) commented that the present convention for short names for mapping units is no Longer adequate, that the need for correlation of interpretations requires correlation of phase names across state and regional boundaries, and that consequently we need a new policy for naming mapping units.

(b) Group (B) commented that the current SCS-Soils-5 interpretation sheets were not suitable as handouts to the general public because of the differing ranges of phases in individual soil surveys. In many instances, the interpretations need to be adjusted to fit the conditions in individual surveys.

E. Recorrelation of Soils with Areas of Published Surveys

A number of published surveys have maps that are still satisfactory, but the names assigned to some soils are out of date. Changes have bee" made in series concepts for a number of reasons. Consequently, the series names now in the published survey may not all be valid. Differences in nomenclature may exist between the area covered by a published survey and adjacent or nearby areas.

E.l. Question. Should more effort be given to reconsidering the correlation of soils in areas with published surveys?

E.2. Question. If reconsideration and some recorrelation of soils seems desirable, how should the results be made available to the public?

Responses to questions E.l. and E.2.

The responses of the discussion groups on this topic differed with respect to the desirability of recorrelating the soils.

(a) All of the groups favored preparation of revised interpretations of older published survey& that have soil maps that are useful for current needs. Three groups indicated they did not favor formal recorrelation of such surveys; that only limited informal correlation that is needed for making revised interpretations should be done in most instances; that only very limited field work for this purpose is justified.

(b) Group (A) recommended that soil maps of older published surveys should not be transferred to a new base map or enlarged and transferred to a new base map.

(c) Group (D) recommended that more effort should be given, as priorities permit, to recorrelation of older surveys provided the interpretations are updated at the same time.

Their suggestions for setting priorities for updating published surveys:

1. Evaluate the information provided by the published survey relative to the current needs in the area. The soil maps of some of the older surveys are satisfactory for current needs; only the soil names and the interpretations need to be updated. Only part of the area of an older survey may need updating to meet a particular need, the remainder being satisfactory for current uses.

2. Determine the resources, in terms of money and people, that are available.

3. Explore the possibilities of cost-sharing arrangements to carry out the work.

The procedure used recently by the Experiment Station in Michigan to update a survey published in 1933 was described as follows:

1. Transects of the delineations on the old soil map (scale 1:62,500) were made to determine composition of the mapping units in terms of current soil classification. Most mapping units were found to have components belonging to two series rather than one.

2. The soil map was enlarged photographically to a scale of 4 inches = 1 mile and the soil boundaries were transferred to an aerial photo base map at that scale. The location of soil boundaries was not changed.

3. The soil survey legend and the interpretations were updated.

4. One hundred copies, in two volumes, of the updated survey were prepared.

5. The updated survey cost about $8,000 and used six months of soil scientists' time, including 3 months of field work.

If a survey is recorrelated, the soil correlation staff should be involved so that the correlation actions taken are recorded.

(d) Suggestions for making the results of recorrelation and updating of interpretations available included preparation of a supplement to the original survey and preparation of revised tables of interpretations only.

F. Notes on the discussion at the plenary session of the conference following the oral presentation of the report:

1. In view of the occasional need to reprint soil surveys in the past and the possibility of that becoming more frequent in the future, a question was raised as to what is the current SCS policy for storing the plates from which the soil maps are printed. Mr. Johnson responded that the press negatives of the soil maps only are being kept for all soil surveys that have been printed in the current 9- by 11-inch format. Those go back to about 1955. When the Advanced Mapping System comes into operation, the data needed to reprint a map would be stored in digitized form.

2. With respect to question C.3., item (c), it was suggested that information on the nature, extent, and location of soils that are handled as taxadjuncts could be kept track of readily if the final correlation for each survey area were put in form for ADP recordkeeping. The Northeast RTSC and a few states now are keeping records of soils handled as taxadjuncts It was suggested that a uniform national system is needed for such records.

3. In response to a question about the force of recommendations and suggestions of the discussion groups of this conference on Standards and procedures for conducting th-: National Cooperative Soil Survey, Mr. Johnson indicated that such recommendations would be treated in a manner parallel to the way recommendations of national committees have been treated in the past. The recommendations have no official status in their present form. Some ideas on which there is wide agreement are likely to be incorporated into formal memoranda or other documents that guide the conduct of the soil survey. Others will need further study.

4. Misgivings were expressed about the validity of reproducing a soil map at a scale substantially larger than the original publication, especially if the larger scale base map showed more ground control than the original soil map. The comments were in reference to the procedure for updating an old survey that is outlined in item E.(c). The large scale and amount of ground control could encourage misuse of the survey for designing building lots and the like, for which the revised survey is not suited. It would be important to include a prominent warning to users about the expanded scale and the original scale and the resulting precision of soil boundaries relative to the detail of the ground control. I" support Of the procedure outlined in item E.(c), Dr. Whiteside pointed to the very great savings in time and money as compared to resurveying and republishing the survey. He thought the convenience of the photo base may override the questions of the cartographic validity of the procedure used.

5. Use Of the term "recorrelation" for procedures less complete and less rigorous than the full, formal correlation procedures was questioned. Recorrelation seems to imply something more than the informal correlation needed to update the interpretation, as suggested in item E.(a).

6. Mr. Johnson commented that revisions in the class limits or the criteria of Soil Taxonomy will take place in an orderly fashion after the system is published. He thought it would be reasonable for regional committees to try to improve the definition of the cambic horizon, as suggested by two of the discussion groups.

The report was accepted by the conference.

SOIL SURVEY INVESTIGATIONS REPORT

Donald E. McCormack*

I. Scope of soil survey investigations projects

Procedures and goals of soil survey investigations have not changed greatly in the last 20 years. The question now is whether the policies established then are still adequate.

Questions asked us now are much more complex than they were 20 years ago. We need now information to evaluate environmental hazards. For this we need, for example, measurements of saturated and unsaturated hydraulic conductivity and of redox potentials at various times of the year. These determinations are time consuming and expensive. In many areas we also need soil information to greater depths than can be reached with an auger. The soil geomorphology teams have been providing some of this information but only for a few areas.

Questions:

1. What new services are needed from soil survey investigations?

   The conference proposes that emphasis should be given to providing information that will permit more thorough evaluation of environmental hazards and the role played by soils (a) as contributors to these hazards or (b) as a part of systems through which the hazards might be reduced or eliminated.

   1a. Laboratory analyses and related field measurements?

   a. Studies of saturated and unsaturated hydraulic conductivity of soils, and studies of water movement over and through soils in the landscape, including water transmission potentials. An evaluation should be made and agreement reached as to the kinds of measurements needed, as well as an evaluation of those ways in which given measurements would be used to better understand water quality and the water balance in various kinds of soil landscapes.

   b. Field tests for the content of free sulfur in soils, especially in surface-mined areas, are needed to permit the most useful classification and mapping of areas where the oxidation of sulfur is likely to create difficult problems in the stabilization and vegetation of land.

   c. Additional measurements of the Atterberg limits of soils are needed. In many states, data developed through cooperative testing programs with the state highway departments, is still not adequate for reliable estimates of liquid limit and plasticity index for some soil series. An alternative to expanding the capability of the soil survey laboratories to perform these studies would be to encourage the states to obtain the tests needed through the SCS soil mechanics laboratories.

*USDA-Soil Conservation Service, Washington, D. C.

d. Development of improved field methods for measuring soil permeability and improved methods of using field clues for estimating soil permeability from field are needed.

e. We need to institute procedures through which a better understanding Of soil water tables in given kinds of soil may be developed. It is proposed that programs be initiated at the beginning of soil surveys whereby a set of wells in selected soils shall be installed and monitored by the soil survey party throughout the course of the survey.

f. Better criteria are needed for predicting the performance of give" kinds of soil for the disposal of various kinds of waste.

g. Better criteria are "ceded for evaluating the trafficability of soils.

h. We should investigate the need for triaxial compression test and explore its use in soil survey interpretations.

i. A national clearinghouse for methods of soil analysis to be used in the soil survey should be maintained.

1b. Soil-geomorphology studies?

The conference recognizes the very important contribution that has been made to the soil survey by the soil-geomorphic studies that have been performed. The information obtained has improved our understanding of soils and landscapes, assisted in the development of Soil Taxonomy, and improved soil survey field techniques.

More short-term projects on special problems of limited scope are recommended, especially in situations where soil-landscape relationships are difficult to determine. It is felt that soil-geomorphic studies should be expanded. One group recommended that one study team per region should be established, and another that a new study team should be established in the Northeast region; Both long-term and short-term projects are needed, and if funds and manpower cannot be increased, then relatively greater emphasis should be given to short-term projects.

It is recommended that additional opportunity and encouragement be given (a) to affording training to state soil survey staffs in the approaches used in soil-geomorphic studies, and (b) to the dissemination of the findings of such studies.

1c. ADP and statistical services?

One group suggested that a soil scientist who is expert in statistical analysis be a part of the soil survey investigations staff. He should have as a major part of his assignment the investigation of needed analysis of soil survey data, and should cooperate with the universities in the coordination and analysis of all soil survey data. It is recognized that the overall need for statistical services by the soil survey entails a very large amount of work. beyond the capacity of such an expert. However, the coordination that could be achieved through such a position would be a significant contribution.

2. Considering that budgetary and personnel restraints are not likely to be reduced, what present activities of SSI should be deemphasized?

2a. Are there specific analyses that could be dropped?

In view of the possibility that funds and manpower available for soil survey investigations may not be increased to provide for the suggested new services, certain of the present activities may need to be de-emphasized. However, there are no suggestions that certain specific analyses could be dropped. One group suggested that relatively too much effort is directed to mechanical analysis. However, it was concluded that the data that is currently being provided by soil survey investigations is well used.

2b. Should we make fewer characterization analyses of complete pedons and concentrate on more detailed characterization of few pedons relying on selected analyses of grab samples for answering most classification questions?

One group decided that fewer characterization analysis of complete pedons will be needed in the future, but those that are chosen for analyses will need to be studied in greater detail. Two groups indicated that the need for partial analyses of grab samples has increased. It was suggested that all grab samples be accompanied by complete pedon descriptions.

2c. Should the soil survey investigations staff spend more time on adapting information available from non-SCS sources (ARS, Experiment Stations, USGS, EPA) to our needs?

The Soil Survey Investigations staff should spend more time adapting information available from sources outside the SCS to the needs of the National Cooperative Soil Survey. It is suggested that efforts should be concentrated on information related to the benchmark soils. Two approaches were proposed to accomplish this objective: (a) an individual of the Soil Survey Investigations staff be made responsible for collecting, reviewing, and distributing the information, or (b) ask the states to perform this function with help from the Soil Survey Investigations staff. To make it easier to research the information, we should encourage authors of papers to use proper key words including the name of the soil series in their papers.

II. Benchmark soils

We have had a benchmark soil program now for almost 18 years. Very few benchmark soil reports have been published. Experiment stations have not used our benchmark soils extensively for detailed studies. On the other hand, certain basic studies concerned with environmental hazards and studies suggested in Topic I are so expensive that they cannot be made on all benchmark soils. Some benchmark soil data are also becoming outdated rapidly and data available for older benchmark soils do not meet modern needs.

Questions:

1. Should we continue the benchmark soil program as formulated now and should we continue to strive for more or less formal publication of benchmark soil reports?

   A general concensus indicated that the benchmark soil program should be directed primarily to the accumulation of data about important soils. Publication of formal benchmark soil reports has proceeded slowly, and all groups indicated that less emphasis should be placed on this activity. The benchmark soils should be used as a basis for planning research.

2. Should we start a new program involving fewer soils and more data? Should we include yield studies, pollution hazard studies, etc.?

   Three groups felt that the current list of benchmark soils includes too many series, and that some series should be dropped from the list. All groups felt that the soils chosen should be studied in detail, with the studies designed to assure that the data can be extended to other soils t" the maximum possible extent. Data in addition to the standard characterization data should be obtained. Engineering test data, applicable pollution hazard studies, yield studies, and other studies related to current land use and soil problems should be included.

3. How should such a program be administered? Nationally, regionally? Should the series selected represent a taxon at the subgroup or great group level or should the selection be made on a land resource area basis?

   The program should be administered regionally, with coordination at the national level; impetus should be given to the program nationally. Three groups proposed specifically that the soil series designated as benchmark soils should be chosen by land resource areas. Two groups proposed that extent, kind of soil, and geographic distribution be used as criteria for selecting benchmark soils. One group cautioned that extent might have to be deemphasized in some cases where pressing needs for information exist for less extensive soils. N" proposals were made for designating benchmark soils on the basis of specific taxonomic categories.

4. How should results be distributed? Should we aim at a formal publication as in the past or should we have benchmark soil folders and a mailing list so that data can be accumulated as they become available?

   There was general agreement that data for benchmark soils should be distributed as they become available to the states where the series occurs as well as regional and national offices. No formal device is "coded for such distribution. It was the concensus that publication should be considered optional. One group concluded that we should continue to plan for formal publication eventually. Some individuals felt that the benchmark soils reports are of questionable value.

5. How many soils should be included? If the program were based on land resource areas should we have one soil for each of our 156 land resource areas?

Specific proposals for the proper number of benchmark soils were not made by one of the groups. Two groups indicated that 6 to 12 soil series per state would be about the right number, and one group suggested one soil be selected per state for each of its MLRA's. Two groups pointed out that careful consideration should be given to existing data, so that it would not be overlooked as additional work is planned for benchmark soils.

6. Should the benchmark soil be one or more pedons, or polypedons of a given series, or should only the series be designated? In other words, should we have benchmark sites that are accessible and conveniently located so that Experiment Station, ARS, EPA research can be done there or the soil re-sampled?

There was a strong concensus that the sites chosen for study of benchmark soils should be located so that they are easily accessible to future research work, and that sites on public land would be desirable. One group proposed that where possible the site of the typifying pedon be included. The question concerning designation of benchmark soils as pedons, polypedons, or series was interpreted differently by the different groups. One group concluded that identification at the series level was sufficient, and this is believed to be the general concensus. However, one group felt that geographically associated groups of soils might be designated as benchmark soils. One group stated that one or more pedons of a given benchmark soil should be sampled. No proposal was made for designating particular pedons or polypedons of a soil series as sites for benchmark soils.

III. Coordination of soil survey investigations and field staff

The Soil Survey Investigations staff has a service and a research function. While it is important that the SSI staff retain enough independence to fulfill its research functions, the research needs of the soil scientist in the field and the RTSC's need to be communicated to the SSI staff more effectively and results must become available more rapidly. Likewise, considering the small size of the Soil Survey Investigations staff its time has to be scheduled carefully.

Questions:

1. Should the planning of soil survey investigations work be more on a regional basis rather than as presently on a state-national basis?

Increased emphasis should be given to the planning of soil survey investigations on a regional basis. The planning for investigations should be coordinated between the Soil Survey Investigations staff, the Regional Technical service Centers, and the stat.2 soil survey group, including both the universities and the SCS at the state level. All should be involved in the early stages of planning proposed projects. As the Soil Survey Investigations Units are now a part of the Regional Technical service Centers, planning, scheduling and coordination with the Soil Correlation staffs and with individual states should be more readily achieved. One group thought it would help if the Head of each Soil survey Investigations Unit was a member of a regional soil research committee, or similar committees of university personnel.

2. Should State Conservationists and Directors of RTSC's be encouraged to assign soil scientists to the SSI staff to work on specific projects or to solve specific problems, especially during the winter?

All groups agreed that assignments of field soil scientists to SSI staffs to work on specific projects or to solve specific problems would be desirable. Such assignments generally should not be made during the most favorable mapping seasons. We should also explore the possibility of working out arrangements between state universities and the SCS involving training and development programs, including graduate study assistantships and laboratory work. Selected soil scientists could work with the SSI staff in performing research in conjunction with formal training at state universities.

Employee development programs are extremely important for soil scientists and all possible avenues should be explored to make them available. Some current SCS training funds should be devoted to this effort.

It is recommended that Employee Development Unit Heads be invited to all Regional Work Planning Conferences to explain availability of training both within and outside of the SCS.

3. Should promising field soil scientists be assigned to a laboratory or to soil-geomorphology unit for 1 or 2 years as part of their career development program?

It was generally agreed that such assignments would be desirable. Assignments might be made for periods 1 or 2 years for in-depth training, or 1 or 2 weeks for more limited or specific training.

It was recognized that problems may arise involving funding for assignments to soil-geomorphology units. It is suggested that each state within the region served by the soil-geomorphology unit share in the expense. Training of this type should be coordinated by the regional office. The possibility of setting up local, county or state-wide projects should also be explored. This could be done with the soil-geomorphology unit providing initial training and assistance but with a competent field soil scientist completing the project with only limited additional assistance.

Discussion

Bartelli - It is not clear whether or not some of the suggestions really represent the concensus of the four groups. For example, was there a concensus on the need for a statistician in Soil Survey Investigations?

McCormack - We will recheck the notes from the recorders to find out. (The wording in the report was adjusted after rechecking the notes.)

Fanning - Is it feasible to develop a field test for sulfur, or sulfides? Study of potential acidity due to sulfides would be better.

Holzhey - There is a field test for potential sulfide acidity being used in tidal marshes. Also there is a very roughly quantitative test using lead acetate that is being tested in Ohio. I believe it has been used by corrosion engineers.

Grossman - There is need for more effort in training and employee development for soil scientists in SCS. Perhaps a special group within Soil Survey should be designated to determine needs and means of satisfying them. Employee development responsibilities should be outlined more explicitly in job descriptions of supervisory personnel.

McCormack - We have a good program for employee development in SCS, and no doubt should make better "se of it than we have in the past.

The report was accepted by the conference.

Recorders - T. Miller. E. Perry, J. Witty, S. Holzhey
Reporter - D. McCormack

CONFERENCE SUMMARY

William M. Johnson*

We have had a good conference that, as always, was stimulating and encouraging to me. I think that all of us get a lift from this biennial meeting. There is good evidence that our system of state, regional, and national technical conferences has been an effective means of introducing new ideas and of achieving needed consistency in our procedures.

Our format this year is a considerable departure from the traditional committee meetings and committee reports of previous conferences. You people wanted to try a different kind of conference, and I am glad that we did. Now I think we need to revise the arrangements again so as to produce more specific decisions and recommendations to send back to the regional conferences. Perhaps we need to reactivate at least some of the conference committees. I shall be glad to have your ideas about this.

The demand for well designed soil surveys with interpretations continues to increase. As national land use policy legislation approaches reality, the realization is growing in states and counties that soil resource data are essential as a basis for evaluation, planning, and regulation of land use. I” many state legislatures laws are being drafted to require the use of soil surveys for evaluation of development plans. In other states erosion and sediment control legislation has been enacted, compliance with which depends on planning and execution of construction so as to protect the soil resources. I” several states there is realization that the soil survey must be accelerated in all counties that await completion. We can look forward to heightened interest in other states in accelerating soil surveys for planning and development.

In order to serve our users we must keep in close touch with them and their needs. Soil scientists must learn the jargon of planners and help them to learn ours. We must keep our procedures and our designs flexible so that we can adjust to meet current needs. For some purposes the old one-inch-to-the-mile maps were ideally suited. For other planning purposes maps of large scale are necessary. For county and multi-county areas maps of scale 1:125,000 or smaller may be best. Some of our users are able to work with the soil map and tables of interpretations, but others require the preparation of simple interpretive maps. Obviously we cannot do everything for everybody, but we should be alert to opportunities to train planners and others in the use and interpretation of soil surveys. In this way we can assure that the surveys will be used and used correctly and that our soil scientists will not be overburdened with application work, to the detriment of basic soil survey field work.

The Soil Taxonomy will be printed within the coming year. We shall shortly be establishing regional committees for the review of proposals for revision of the classification. We do not expect to have a standing national committee to advise on revision of the Taxonomy, but we shall use *ad hoc* national committees to deal with problems as they arise.

The third edition of the Soil Survey Manual should be out before this conference convenes again. Also by that time we hope to have the Soil Survey Procedural Handbook completed, if not published. These documents will help us and our cooperators and users to maintain consistency of field operations and documentation and to understand better the uses and limitations of soil surveys.

*Deputy Administrator for Soil Survey, Soil Conservation Service, Washington, D. C.

I thank all of you for your contribution to the success of this conference. As always, we are glad to have representatives from cooperating and using agencies. This year we welcome a representative from ARS. We are glad to have Dave Unger talk to us about the role of conservation districts in the use and support of soil surveys. Our Canadian colleagues contributed many useful ideas to the discussions, and we are glad that their interest in this work continues to parallel our own.

I hope you all have a pleasant trip home, and I shall look forward to seeing most of you again two years from now.

Attachment No. 1

2nd Approximation

PROGRESS REPORT

Task Force for Guidelines for Reconnaissance Soil Surveys
National Cooperative Soil Survey

1-22-73

Members Present:

J. R. Coover, SCS - Texas
R. C. Huff, SCS - Calif.
V. C. Link, SCS - N. Mex.
E. A. Naphan, SCS - Nev.
O. C. Olson, USFS - Washington, D. C.
F. F. Peterson, Univ. Nev. - Reno
C. A. Steers, SCS - Texas
J. M. Williams, SCS - WRTSC

Introduction

The task force agreed that its most valuable contribution would be clarification of the present confusion with which the term "reconnaissance soil survey" is treated, in comparison with "detailed soil surveys." The committee discussed Chapter I, 2nd draft of the new Soil Survey Manual, and its treatment of reconnaissance soil surveys. We were unanimous that this draft chapter does not appear to resolve all past and present confusion.

The problem is similar to that of some classic soil series which were so broadly and vaguely defined that they carried different meaning to different people. We suggest a solution similar to that of soil series that have vague concepts: the definition of "reconnaissance soil survey" should be made operational, it should be narrowed, it should relate to other types of soil surveys, and the compromised name itself should be dropped. We recognize this is a drastic departure, but the stigma attached to "reconnaissance" seems insurmountable; the solution we propose is not unlike the change from the controversial A-B-C horizon designations to the operationally defined kinds of diagnostic horizons used in the U.S. Soil Taxonomy.

Our revision of meaning for "reconnaissance soil survey" demanded congruent definitions for other types of soil surveys, operational definition of terms used to define the types, and a different terminology for the types of soil surveys. These follow.

Soil Maps and Soil Surveys

To provide a context for our concepts of "reconnaissance soil surveys" we devised these capsuledefinitions of maps and surveys:

(1) Soil maps: soil maps show the geographic distribution of different kinds of soil and the mapping units are defined by their component soils; the soils are classified according to the criteria of the Soil Taxonomy.

(2) Soil survey: a soil survey is a soil map and accompanying report which are based primarily on field methods1/ for identification of kinds of soils and soil boundaries.

(3) Generalized soil map: a generalized soil map (also "General Soil Map") is one made by abstraction from a more detailed soil survey map.

(4) Schematic soil map: a schematic soil map is one made with little or no field investigations. Soils are identified by interpretation from aerial photos, geologic and geomorphic features, vegetation, climate, or other information about genetic factors.

Quality Control

Additionally, we agreed that, for quality control, all types of soil surveys require that soil handbooks, including identification legends, mapping unit descriptions, taxonomic unit descriptions, and interpretations be maintained during the survey. Each soil survey should be reviewed by correlation procedures of the National Cooperative Soil Survey. we also agreed that some type of publication of each soil survey, and distribution outside of the agency which does the work should be a standard practice, even though numbers of copies are limited.

Terms for Describing Soil Survey Operations

The task force found it needed objective, or "operational" definitions of several terms that were used to describe the procedures of soil surveying; individual understandings of these terms are variable enough that during discussion unwitting confusion occurred unless we had explicit definitions at hand. The following partial list of terms repeats most of the traditional understandings, but is intended to stress those operations--those things we &--which are characteristic of various soil survey procedures.

1. Transect: (1) The field procedure of crossing delineations or landscape units along selected lines to determine the pattern of pedons with respect to landforms, geologic formations or other observable features. Thus, visible, or simply determinable features are related to soils, and soil occurrence can be predicted locally.

1/Remote sensing techniques are becoming increasingly important.

Also, (2) a statistical sampling procedure of crossing delineations on selected or random lines, and identifying pedons at predetermined points for subsequent formal or informal statistical evaluation to establish the composition and variability of a delineation or mapping unit.

2. Traverse: Validation of the predicted boundaries or composition of a delineation by entering it, or crossing it, and identifying pedons at selected or random positions.

3. Observation: Visual checking of landscape features, exposed geological formations, or chance exposures of pedons from within or without a delineation to project boundaries and composition from previously determined relations; pedons are not examined; air photos may be used as guides, but this is a field operation and not merely photo interpretation. This is a less intensive operation than traversing.

4. Air Photo Interpretation: Plotting boundaries and soil composition of delineations (or other landscape features) from photo features which have been previously related to soil occurrence. This is basically an office procedure.

5. Sampling: (1) taking physical samples from pedons for later laboratory or field analyses.

Also, (2) identifying pedons in a systematic or random fashion for subsequent statistical analysis.

6. Identification: (1) the systematic determination of the properties and features of a pedon (or pedons of a polypedon), including laboratory analyses where needed, and subsequent keying through an established soil classification system to find the class(es) within which the pedon (or polypedon) fits, or the absence of such a class(es), or determination of status as a taxadjunct. This operation concerns naming of individual things.

Also, (2) the immediate perception on viewing or brief examination (i.e., the gestalt) of the class affinity (name) of a pedon or polypedon.

7. Correlation: The field and office procedures of review by which the accuracy and appropriateness of taxonomic unit identification, mapping unit design, mapping legends, field notes, pedon descriptions, and other soil survey operation are maintained.

Terms for Describing Kinds of Mapping Units

The recognition of different types, or "orders" of soil surveys, which is presented later, demands analysis of the kinds of mapping units used in each. We found we had no term explicitly identifying a mapping unit of only one component, regardless of the level of taxonomic abstraction at which that component is identified. Definitions for "delineations", "consociations", "associations", and "complexes" are given here to provide the complete context within which each term is used; the term "delineation" is included to emphasize that mapping units per se are groups, or classes, of similar soil-landscape areas (i.e., delineations), and as such are as wholly open to levels of abstraction as are the soil taxonomic units.

1. Delineation: A selected and differentiated portion of a landscape circumscribed by a boundary on a map and that contains an unique composition and pattern of soils; the boundary of a delineation can be placed at the boundary of a polypedon identified by use of soil series-level differentia, or at the boundary of a polypedon or contiguous polypedons identified by use of soil family (or higher)-level differentia, or by application of phase-level differentia.

2. Consociation: A mapping unit in which only one identified soil component (plus allowable inclusions) occurs in each delineation. The term consociation has not been used in soil science but is needed to identify mapping units of only one identified component. It is manufactured from the element con ("opposed to" or "negative") and the element sociatc (from association, "to join", "to share", "companion") and means things which are single, not a companion of other things. The term reportedly has been used by plant ecolologists to identify stands of single species as opposed to associations of several plant species.

3. Associations: Definition as given in Soil Survey Memorandum 66.

4. Complexes: Definition as given in Soil Survey Memorandum 66.

Criteria for Identifying Types, or "Orders" of Soil Surveys

We are all aware that different intensities of field study, different degrees of detail in mapping, different phases or levels of abstraction of taxonomic units, and different mapping unit designs produce soil surveys of widely ranging applicability for problem solving. We have also become aware of the difficulty of communicating to each other, let alone laymen, what type of soil survey we have, what applicability it has, or the levels of confidence it deserves. This task force concluded its major job is to provide objective guidelines for the various types of soil surveys, and thus provide a basis for meaningful communication on such important matters as survey objectives and survey design.

The committee concluded after extended discussion what types of soil surveys are best characterized by the kind of mapping units and their composition, intensity of field procedures and map scale. This would put in focus the refinement of distinctions among mapping units and the purity of mapping unit delineations. An interaction of these factors establishes a given confidence level for making predictions. Obviously, one must know the needs of the users of a soil survey before he can design the survey to answer those needs. Four objective attributes of soil surveys seem sufficient to distinguish between different types:

1. Kinds of mapping units.

2. Kinds of taxonomic units.

3. Kind and intensity of field procedures.

4. Map scale and minimum size delineation.

After considering the different ways we now map soils to serve different needs of users, we concluded five levels or "orders", of soil surveys are needed to provide a reasonable division of level of detail, intensity of field work, and applicability to various uses. We suggest these different types of soil surveys be called "1st Order,...5th Order Soil Surveys", in similarity to the civil engineers' identification of intensity and confidence of their surveys:

New Designation	Traditional Name
1st Order Soil Survey	High Intensity Detailed Soil Survey
2nd Order Soil Survey	Low Intensity Detailed Soil Survey[1/]
3rd Order Soil Survey	Reconnaissance Soil Survey[2/]
4th Order Soil Survey	Reconnaissance Soil Survey
5th Order Soil Survey	Exploratory Soil Survey

In Table 1 we list the criteria by which the various orders of soil surveys could be identified. In Table 2 we list illustrative uses to which the different orders of soil survey might be put. We should note that 2nd Order soil surveys are suggested to identify a rather intense mapping effort which results in very well defined associations; the intensity of work is like that of 1st Order soil surveys, but since the mapping unit design is so different, interpretations and uses are different. In 3rd Order soil surveys there is a drop in intensity of field work and commonly an increase in level of abstraction for both mapping units and taxonomic units; again, permissible use change.

[1/] Also considered by many as reconnaissance soil surveys. See p.436, Soil Survey Manual, Objective 1.

[2/] Sometimes referred to as "semidetailed soil surveys", or "detailed reconnaissance", Soil Survey Manual p.435.

Nomenclature of Mapping Units

Although it is traditional and desirable to name mapping unit components by soil series names or by the "common family name", the committee concluded that a modified convention should be permitted for 3rd, 4th, and 5th Order soil surveys in those cases where the taxonomic identification of components is at the family or higher taxonomic level. The mapping unit identification symbol accompanied by a listing of components should be acceptable "names".. The list of taxonomically identified component soils will be the basis for correlation in any case. The identifying number or descriptive term provides a practical and short name for the local user. Our proposed conventions for naming mapping units follow:

1. 1st Order Soil Surveys:

   Named by a phase(s) of a soil series.

2. 2nd Order Soil Surveys:

   Named as an association of phases of soil series.

3. 3rd Order Soil Surveys:

   In areas where soil series are established mapping units would be named by phases of soil series (e.g., Alpha-Beta association) or by phases of common family names when taxonomic identifications are phases of soil families (e.g., Beta-Theta families). (The use of a hyphen connecting the common family names along with the word "families" should be a suitable convention for distinguishing these names from traditional soil series names.) In areas where soil series have not been established and taxonomic identification is at the family level alternative names are:

   (1) Mapping unit identification symbol and a detailed listing of constituents by phases of soil families; e.g.:

Identifying Mapping Unit Symbol	Constituent Soils	Proportion
20	Aquic Torriorthents, fine, montmorillonitic (calcareous), mesic, 0-2% slopes	50%
	Typic Torriorthents, fine, montmorillonitic (calcareous), mesic, 4-30% slopes	40%
	Inclusions of Typic Torripsamments and Duric Natrargids	10%

(2) An association named by phases of subgroups, with a listing of the components by phases of soil families.

4. 4th Order Soil Survey:

(1) In areas where the taxonomic identification is at the family level and soil series have been established, associations should be named by the common family names (e.g., Beta-Theta families). (Again the use of a hyphen and the word "families" indicates a family-level identification).

(2) Associations named by phases of subgroups or great groups as appropriate (e.g., Durargids-Nadurargids association, hilly).

(3) Mapping unit identification number with a listing of components identified by phases of subgroups or great groups.

5. 5th Order Soil Survey:

(1) Associations named by phases of great groups, suborders or orders as appropriate.

(2) Mapping unit identification number with a listing of taxonomically identified components.

Supporting Morphological Descriptions for 3rd and 4th Order Soil Surveys

In many places where 3rd and 4th Order soil surveys are being made for general planning purposes soils of a single taxonomic class occur in large bodies and the various soils are not particularly variable within the soil survey areas. For such areas taxonomic identification is at times made only at the family level to (1) facilitate rapid field work, (2) to generalize somewhat on series-level variability if it occurs. Valuable information on horizon thickness, common textures, structures, and other morphological features is collected during such a survey and should be documented.

The task force was in agreement that when the taxonomic identification was at the family or higher categorical level a description of a representative pedon for each kind of soil mapped should be included in the descriptive legend and subsequent soil survey report. Separate pedon descriptions for various phases of a family, subgroup, etc. would not normally be needed. The site location for each illustrative pedon should be given. These pedon descriptions are not to be considered modal. The mapping unit description would include the variability of the family, etc. and describe ranges in characteristics that occur within the survey area. Of course the characteristics described must not fall outside the limits of the taxa. In addition to the convential convention for describing pednns a block of the committee suggested the descriptions could be given in the abbreviated form used for field descriptions. It was argued that descriptions are intended for the use of soil scientists, or other equally technically competent workers, and the use of the abbreviated form would be one way to minimize publication costs. An example of such a form is appended along with an index for the abbreviations which would also be included in reports.

A Quality Control Procedure

The task force discussed at some lengths the need to achieve quality control of field operations and to develop guidelines for precisely defining soil survey data. It was recognized that particular problems are encountered in very heavily forested and highly dissected areas in determining map unit composition and maintaining purity. The "Random Transect Method" was developed by Steers and Hajek and is one acceptable means of sampling any map unit for composition and consistence. Following is a short outline of the Random Transect Method prepared by C. A. Steers.

The "Random Transect Method" was developed primarily for use in 2nd Order soil surveys in heavily forested areas or other areas of limited ocular observation. This procedure of sampling is of great value where true extent and exact composition for mapping units is of upmost importance. It is not intended that this procedure be used in design of mapping units, but rather it is an approach to determine map unit purity and composition. It also can be used for sampling other order surveys for confidence and consistence of composition.

The method of sampling is systematic and statistically valid. A soil scientist delineates mapping units from direct soil examinations and identification procedures from traverses of each delineation. At the same time he locates and records representative transects that characterize the delineations. A random selection is made from these representative transects to be sampled by field investigations. Two such random selections and samplings are required: one near the initiation of survey to define units in the descriptive legend and another near the end of survey to characterize mapping units for entire survey area. All randomly selected transects are investigated and sampled by field procedure and data recorded. Statistical analysis is then completed, summarized, and recorded by mapping units. Soil surveys in which quality is controlled by these procedures are accurate, of high quality. However, use is restricted by area of minimum size delineation.

TABLE 1

CRITERIA FOR IDENTIFYING KINDS OF SOIL SURVEYS

Order of Soil Survey1/	Kinds of Mapping Units	Kinds of Taxonomic Units	Intensity of Field Procedures for Quality Control	Appropriate Scales for Published Soil Maps	Minimum Size Delineation2/
1st	Consociations, or complexes	Phases of soil series	Soils in each delineationare identified by field examination.	1:7,920 to 1:31,680	1/2 acre to 10 acres
2nd	Narrowly defined associations	Phases of soil series	Soils are identified in each delineation by a systematic procedure of traversing, or by transecting that provides a valid statistical sample.	1:20,000 to 1:63,360	5 acres to 40 acres
3rd	Consociations & associations	Broad phases of soil series and Phases of soil families	Soils are identified in representative delineations by a systematic procedure of traversing or by transecting that provides a valid statistical sample. Projection made by traverse and field observations.	1:31,620 to 1:250,000	40 acres to 640 acres
4th	Broadly defined associations	Phases of soil families Phases of Subgroups Phases of great groups	Representative delineations are transected and information projected by photo interpretation and verified by broadly spaced observations.	1:125,000 to 1:500,000	640 acres to 10,000 acres
5th	Very broadly defined associations	Phases of great groups, suborders or orders	1st or 2nd order soil surveys are made on selected areas (15 to 25 sq. mi.) to identify soils and establish soil patterns on natural landscapes. Projections are made with reliance on broad landscape interpretation and verification of soils at strategically located points.	1:500,000 to 1:1,000,000	10,000 acres

1/ Soil surveys of all Orders require maintainance of a soil handbook (legend, mapping unit descriptions, taxonomic unit descriptions, field notes, interpretations) and review by appropriate correlation procedures of the National Cooperative Soil Survey. Work plans for many survey areas list more than one order; the part to which each is applicable is delineated on a small scale map of the survey area.

2/ This is the minimum size delineation imposed by limitations of the map scale. In practice the minimum size delineation specified for a map unit for 2nd order soil surveys is generally larger than the minimum shown.

///

TABLE 2

APPROPRIATE USES FOR DIFFERENT ORDERS OF SOIL SURVEYS

Orders	Intensity of Planning for Land Use or Management
1st	Intensive planning such as predicting specific uses and treatment of discrete tracts of land for most cropland but not for site selection for structures. Soil series interpretations are valid for areas larger than specified minimum size.
2nd	Operational planning for rangeland. woodland, some cropland tracts; not for site selection for structures. Interpretations limited to overall behavior of soil series occurring together in areas larger than specified minimum size.
3rd	General planning--applicable to county or multi-[1] county planning districts, areas of extensive use such as some rangelands, forested lands and arid lands. Interpretations valid total extent of a map unit; not designed for interpretations for tracts of management size.
4th	Broad planning--applicable to multicounty plan-[1] ning, large RC&D and RCOG, statewide planning and large state planning districts.
5th	Very broad planning--regional planning, statewide[1] planning.

[1] 3rd, 4th, and 5th Order soil surveys aid in locating potential areas for 1st and 2nd Order soil surveys.

APPENDIX 1

ILLUSTRATIVE PEDONS FOR THE SOIL FAMILIES MAPPED IN THE __________ AREA

Caution: These pedons are neither modal, in the sense of a soil series definition, nor do they reflect the intensity of field study characteristic of detailed soil surveys. They are intended as technical aids for future mapping or interpretations. See the key to morphological symbols at the end of this appendix for explanation of symbols.

Horizon (1)	Depth inches (2)	Color Dry (3)	Color Moist (4)	Texture (5)	Structure (6)	Consistence Dry (7)	Consistence Moist (8)	Consistence Wet (9)	pH (10)	$CaCO_3$ (11)	Roots (12)	Boundary (13)	Coarse Fragments % vol. (14)	Other (15)

1. Mollic Haplargid, loamy-skeletal, mixed, mesic (MU 45,72)[1]

Horizon	Depth	Dry	Moist	Texture	Structure	Dry	Moist	Wet	pH	$CaCO_3$	Roots	Boundary	Coarse Fragments	Other
A1	0-2	10YR 5/2	10YR 4/3	vfsl	m	so	vfr	ss,po	7.0	eo	f1,m1	as	10	vesicular
B21t	2-5	10YR 5/3	10YR 4/3	vgscl	1fsbk	so	vfr	s,p	7.0	eo	vf2,f2	as	45	....
B22t	5-21	....	7.5YR 4/4	vgscl	2msbk	h	fr	vs,vp	7.2	eo	vf2,f2	aw	40	clayskins
C1ca	21-29	....	10YR 4/4	vgcosl	m	so	vfr	ss,po	8.4	ev	vf1	cs	40.	....
IIC1ca	29-32	....	10YR 5/4	vgcos	m	so	vfr	so,po	8.4	ev	vf1	....	80	....

Location: NE¼ SE¼ S23 T90N R50E, 50 ft. NW of intersection of Hwy. 745 and ranch road. Range in Characteristics for Survey Area: thickness of A1 horizon ranges from 2 to 4 inches; texture of B2t horizon ranges from a very gravelly sandy clay loam to a very gravelly and cobbly loam, depth to gravelly substratum ranges from 20 to 36 inches; in places the C1ca horizon is weakly and discontinuously cemented.

2. Typic Camborthid, coarse-loamy over sandy or sandy-skeletal, mixed, thermic (MU 21, 23)

Horizon	Depth	Dry	Moist	Texture	Structure	Dry	Moist	Wet	pH	$CaCO_3$	Roots	Boundary	Coarse Fragments	Other
A1	0-3	10YR 6/3	10YR 4/3	ls	m	so	vfr	so,po	7.3	eo	vf1,f2,m1	as	10	vesicular
B2	3-15	10YR 7/3	10YR 5/3	sl	1cpr	so	vfr	ss,po	7.2	eo	vf2,f2	cs	5	....
B3	15-24	10YR 6/4	7.5YR 4/4	sl(-)	m	so	vfr	ss,po	7.7	eo	vf1,f1	as	15	....
IIC1ca	24-32	10YR 7/2	7.5YR 5/6	gs	sg	lo	vfr	ss,po	8.4	ev	vf1,f1	gs	35	....
IIIC2ca	32-40	10YR 7/2	7.5YR 4/4	gs	sg	lo	vfr	so,po	8.2	e	vf1	....	65	mottled

Location: S32, T87N R50E, 500 ft. ESE of prominent rock outcrop. Range in Characteristics for Survey Area: thickness of vesicular A1 horizon ranges from 1 to 3 inches; depth to gravelly substratum ranges from 20 to 30 inches; a very gravelly sand substratum is more common than a sandy substratum.

[1] Numbers in parentheses refer to map units in which this soil occurs.

KEY TO MORPHOLOGICAL SYMBOLS FOR PEDON DESCRIPTIONS

1. Horizon Notation Suffixes

- ca - pedogenic calcium carbonate
- m - strongly cemented or indurated
- si - pedogenic silica
- t - pedogenic clay accumulation

2. Color - Munsell color notation used

3. Soil Texture

st	- stony	l	- loam
k	- cobbly	sl	- sandy loam
g	- gravelly	sil	- silt loam
vcos	- very coarse sand	scl	- sandy clay loam
cos	- coarse sand	sicl	- silty clay loam
s	- sand	cl	- clay loam
fs	- fine sand	sc	- sandy clay
vfs	- very fine sand	sic	- silty clay
ls	- loamy sand	c	- clay
(+)	> 18% clay	(-)	< 18% clay

4. Structure

Grade
- m - massive (structureless)
- sg - single grain (structureless)
- 1 - weak
- 2 - moderate
- 3 - strong

Size

vf	- very fine	c	- coarse
f	- fine	vc	- very coarse
m	- medium		

Type

gr	- granular	cpr	- columnar
cr	- crumb	abk	- angular blocky
pl	- platy	sbk	- subangular, blocky
pr	- prismatic		

5. Consistency

Dry		Moist	
lo	- loose	lo	- loose
so	- soft	vfr	- very friable
sh	- slightly hard	fr	- friable
h	- hard	fi	- firm
vh	- very hard	vfi	- very firm
eh	- extremely hard	efi	- extremely firm

Wet stickiness		Wet plasticity	
so	- nonsticky	po	- nonplastic
ss	- slightly sticky	ps	- slightly plastic
s	- sticky	p	- plastic
vs	- very sticky	vp	- very plastic

6. Soil pH

- 5.6-6.0 medium acid
- 6.1-6.5 slightly acid
- 6.6-7.3 neutral
- 7.4-7.8 mildly alkaline
- 7.9-8.4 moderately alkaline
- 8.5-9.0 strongly alkaline
- above 9 very strongly alkaline

7. $CaCO_3$

- eo - non effervescent
- ve - very slightly effervescent
- e - slightly effervescent
- es - strongly effervescent
- ev - violently effervescent

8. Roots

Diameter classes
- mi - micro, less than 0.075 mm
- vf - very fine, 0.075 to 1 mm
- f - fine, 1 to 2 mm
- m - medium, 2 to 5 mm
- co - coarse, greater than 5 mm

Abundance classes
- v_1 - very few
- 1 - few
- 2 - plentiful
- 3 - abundant

9. Horizon boundaries

Distinctness

va	- very abrupt	- transition less than 1 mm
a	- abrupt	- transition less than 1 inch
c	- clear	- transition 1 to 2½ inches
g	- gradual	- transition 2½ to 5 inches
d	- diffuse	- transition greater than 5 inches

Topography
- s - smooth
- w - wavy
- i - irregular
- b - broken

10. Coarse fragments (dominant size class)

- g - gravel
- k - cobbles
- st - stones

Attachment No. 2

REPORT OF THE NATIONAL TASK FORCE ON ORGANIC SOILS

National Work Planning Conference
Charleston, South Carolina
January 1973

The Task Force was formed on June 6, 1972 and is composed of the following members:

W. E. McKinzie - SCS, RTSC, Lincoln, Nebraska (Chairman)
W. C. Lynn - SCS, Soil Survey Laboratory, Lincoln, Nebraska (Secretary)
H. R. Finney - SCS, Univ. of Minnesota, St. Paul
R. S. Farnham - University of Minnesota
J. E. Witty - SCS, RTSC, Upper Darby, Pennsylvania
J. D. Nichols - SCS, RTSC, Ft. Worth, Texas
S. Rieger - SCS, Palmer, Alaska
J. F. Davis - Michigan St. Univ., East Lansing, Michigan
D. F. Slusher - SCS, Alexandria, Louisiana
E. W. Neumann - U. S. Forest Service, Eastern Region, Div. of Lands, Mineral, Soils and Watershed Management

The first and only meeting of the task force was held in St. Paul, Minnesota the week of November 27 - December 1, 1972. All task force members were present. The following persons also attended:

D. Boelter - Northern Conifers Laboratory, USDA - Forest Service, Grand Rapids, Michigan
J. Day - Soils Research Institute, Canada Agriculture, Ottawa
G. H. Earle - SCS, East Lansing, Michigan
O. Finkelson - SCS, St. Paul, Minnesota
K. C. Hinkley - SCS, Batavia, Illinois
D. Hoffman - Dept. of Land Resource Science, Univ. of Guelph, Guelph, Ontario, Canada
A. Klingelhoets - SCS, Madison, Wisconsin
S. Shetron - Michigan Technological University, Houghton, Michigan
B. Smith - Soil Research Institute, Canada Agriculture, Winnipeg,, Canada

The following problems and suggestions were given to the Task Force for consideration:

1. Prepare suitability grouping of organic soils for agriculture

2. Prepare interpretative guides for the use and management of organic soils for:
   - Agriculture
   - Forestry
   - Engineering
   - Wildlife
   - Commercial use of peat

3. Review problems and suggestions relating to organic soils submitted to the Deputy Administrator for Soil Survey from the Principal Soil Correlators and the Heads of Soil Survey Laboratories.

In addition, we were asked to review the Regional working planning reports and consider their proposals and comments.

4. As the organic Task Force is of short duration, discuss the need for a National Committee to continue working on the classification, use and management of organic soils and if such a committee is needed, how should it function so as to get the most accomplished.

After considering the above proposals and comments a program was arranged to cover the following items:

1. Suitability grouping of organic soils for agriculture.
2. Interpretative guides for:
   - Agriculture
   - Forestry
   - Engineering
   - Wildlife
   - Commercial uses of peat
3. Proposed changes in Soil Taxonomy
4. Form SCS-Soils-5
5. The inclusion of Hydraquents with the Hfstosol Committee
6. Additional committees to obtain information requested.
7. Future of the committee

Actions and Results of_ the Committee

1. A SUITABILITY GROUPING OF ORGANIC SOILS FOR AGRICULTURE

The preparation of this proposed grouping was prepared after the following three possibilities were discussed by those attending the meeting:

1. Use the land capability classification as outlined in Soils Memorandum SCS-22 dated May 19, 1958 for classifying organic soils for agriculture.
2. Propose changes in the land capability classification as outlined in Soils Memo-22 to better classify the organic soils.
3. Prepare a suitability grouping of organic soils for agriculture separate from the land capability classification used for mineral soils.

The committee voted in favor of item 3 above. A copy of the proposed Suitability Grouping of Organic Soils for Agriculture is on page 11. Dr. Doug Hoffman, University of Guelph, Guelph, Ontario, Canada, discussed the "Use Capability Classification for Organic Soils" prepared by the

University for Ontario and was very helpful in the preparation of the "Suitability Grouping For Agriculture" prepared by the Task Force committee. A "Development Difficulty Rating" following the system proposed by the University of Guelph was also prepared. This proposal is on pages 15 & 16 following the suitability grouping. The Agricultural committee also prepared suitability ratings for various crops. Guide sheets 1 and 2 (pages 17 and 18) are examples of how various soil features, affecting the use of a particular crop or group of crops, can be rated. Guide sheets would aid SCS technicians, County Agents and others in outlining the soil features that would be limiting or desirable for the production of a particular crop or group of crops.

2. INTERPRETATIONS OF ORGANIC SOILS FOR THE PRODUCTION OF FOREST PRODUCTS

Two rating systems were developed. One is based strictly on productivity and the other system outlines use potential groups based on ratings assigned to selected indicator properties. (Pages 19-23) The Forestry Committee would appreciate appropriate persons in the Universities, Colleges, U.S. Forest Service, and Soil Conservation Service reviewing these systems and returning their evaluations to the Forestry Committee.

3. ENGINEERING INTERPRETATIONS

The Engineering Committee reviewed Form SCS-Soils-5, Rev. May 1972, and in addition prepared a guide for rating soils for "Dwellings with Basements." (Copy of their report is on pages 24-32).

Recommendations for modification and use of Soils-5. prepared by the Committee, were discussed with representatives of the Washington office the week of December 11, 1972.

The committee emphasized two points:

(1) That rating systems need to be applicable to both mineral and organic soils.
(2) That the proposed system of rating engineering uses will require a great deal of additional testing and revision to ensure the proper ranking. In addition, criteria and values need to be set up for uses such as roads. land fills, dwellings without basements, etc.

4. INTERPRETATIONS FOR WILDLIFE HABITATS

Because of other activities of the Task Force the Wildlife Committee only met for a short period. The committee made five recommendations. These recommendations along with their report is on page 33.

5. COMMERCIAL USES OF PEAT

The American Society For Testing and Materials has issued a standard classification of Peats, mosses, humus, and related products. This classification has a fixed designation of ASTM Designation: D2607-69. People interested in locating areas for commercial peat are contacting the Soil Conservation

Service, Experiment Stations and others for assitance in the location of suitable peat areas. For this reason the committee recommended that these standards should be made available. (Copy on page 34.)

6. SOIL TAXONOMY

Suggest ions for changes, additions and deletions were submitted in the form of regional reports, correspondence, telephone requests and as a result of field investigations. Because many of these proposals were included in the material the Task Force committee was to consider, these changes were compiled and discussed by the committees. The summary and recommendations of the committee are on pages 35-42 of this report.

There has been some misunderstanding about the committee reviewing these proposals. It is not the intent of the committee to bypass the Soil Taxonomy Committee but to get the proposals out for review and comment before recommending changes to the Taxonomy Committee for their review.

RECOMMENDATIONS OF THE TASK FORCE ON ORGANIC SOILS

The Task Force on Organic Soils recommends the following:

(1) A National Committee on Organic Soils be continued for a period of two years for the purpose of:

a. Reviewing. amendments to Soil Taxonomy relating to the Order of Histosols.

b. Revising the "Suitability Grouping of Organic Soils For Agriculture" based on comments and suggestions received after review and testing.

c. Preparing guide sheets and interpretative information for native vegetation for grazing. The Range Conservationists would be asked to assist with the preparation of this material.

d. Continuing with the preparation and review of interpretative material for the use and management of organic soils for forestry, engineering, wildlife, and commercial uses of peat.

(2) The personnel presently on the Organic Soil Task Force be retained on the proposed Committee with the addition of an agronomist, a biologist and an engineer.

(3) The work of the Committee be carried on through correspondence, committees and a conference of one week duration. The conference should be scheduled after the 1974 regional work planning conference and prior to the 1975 national work planning conference.

In order to continue the work outlined by the Task Force Committee, the following subcommittees are suggested:

1. Agriculture

   J. F. Davis (Chairman)
   E. W. Hoffman
   G. B. Lee
   J. D. Nichols
   J. E. Witty
   A. J. Klingelhoets

2. Forestry

   E. Neumann (Chairman)
   S. Rieger
   H. R. Finney
   S. Shetron
   R. E. Smith
   D. Boelter

3. Engineering

   D. F. Slusher (Chairman)
   K. C. Hinkley
   W. C. Lynn
   J. Day
   R. S. Farnham
   G. Earle

4. Commercial Uses of Peat

   R. S. Farnham (Chairman)
   W. Lynn
   J. Day

5. Wildlife

   J. Bedish (Chairman)
   H. R. Finney
   J. Mathison

6. Consistence and Moisture Classes for Use in Describing Organic Soils

   J. E. Witty (Chairman)
   S. Rieger
   R. Grossman
   R. Johnson
   D. Hill

7. Hydraquents - Relating the suitability grouping and use and management of Hydraquents to organic soils and additional interpretative information as needed.

J. D. Nichols (Chairman)
1.
2.
3.
4.

(4) That the proposed amendments to Soil Taxonomy (pages 35-42) be included with the National Work Planning Conference Report for testing and comment. Also request that the 1974 Regional Work Planning Conference comment on these amendments and submit their comments to the National Organic Committee. The National Organic Committee will review the comments and will submit all approved amendments to the appropriate Chairman of the Review Committee for Changes in Soil Taxonomy.

(5) That the suitability groups, guide sheets and other interpretative guides (pages 11-34) also be included in the National Work Planning Conference Report for review and comment. Also request that the 1974 Regional Work Planning Conference comment on these guides and submit their comments to the National organic committee.

(6) That Hydraquents be included as a part of the responsibilities of the National Organic Committee.

(7) That special attention be give" to the recognition and in the selection of "Natural Areas" of organic soils along with providing technical assistance as outlined in Environment Memorandum - 13, dated November 6, 1972.

Comments On Additional Items

Submitted to the Taak Force

MIDWEST REGIONAL TECHNICAL SERVICE CENTER
All items covered

WESTERN REGIONAL TECHNICAL SERVICE CENTER

1. Use of sapric materials as soil amendments. Suggest: The Committee on commercial uses of pest consider this request.

2. Would it be worthwhile to break-up a placic horizon mechanically to improve drainage in housing and other construction areas?

comment: As soils with placic horizons have been observed in New Brunswick, Canada, John Nowland, Correlator for the Maritime Provinces of Canada, was contacted for his recommendation. His recommendation stated "that if the placic horizon is continuous and the saturated vertical hydraulic conductivity of the material underlying the placic horizon exceeds 0.2 inches per hour, then drainage should be materially improved by breaking up the pan. Whether it is worthwhile would depend upon the depth of the placic horizon and the cost of the machinery that can both penetrate to the desired depth and obtain traction on the surface."

3. Artificial drainage of organic soils for agriculture is not now recommended in Alaska, but is being done in other cold areas. Would it be worthwhile to investigate the potential use of drainage in cold organic soils for agriculture?

Comment: Dr. Don Boelter, U. S. Forest Service, has done considerable work on drainage of organic soils and has also observed such work in Europe. The above question was directed to Dr. Boelter and the following is quoted from his letter:

> "I don't believe the cold climate would limit the drainability of organic soils, unless the length of time it is frozen is a factor. There is some evidence from Europe to show that drained organic soils are colder than undrained, presumably due to the lower heat capacity and heat conductivity. It would seem to me, however, that the limiting factor for crop production would be the climate (length of growing season). If the growing season is sufficiently long for the crop involved, I would think that artificial drainage could be considered on these soils in Alaska. Of course, when you speak of growing seasons, you must also consider the fact that there is often cold air drainage into organic soil areas which often occupy the lowest point in local topography."

4. The need for an illustrated guide to help identify plant remains.

comment: Need to research to see what is available. Dr. Farnham is going to check to see if information is available.

5. Salt water intrusion and feasible reclamation. Mr. Huff, California. cites as an example brackish water coming back from the bay, inasmuch as all the delta land in California is below sea level with the resulting accumulation of salt through evaporation. Present control is by irrigation. Could better reclamation means be found? At present there is spirited controversy going on over the correct water table to maintain to prevent the salt water from intruding. Mr. Huff indicates SCS is not active in this discussion.

Comment: Problem too large for Committee. If this information could be obtained it would be useful to apply to other areas on the amount of subsidence that could be allowed. Also how much subsidence could take place and still be possible to remove water by pumping.

6. Subsidence at the present time measures about 2 inches per year in the delta area of California. Needs study to determine that the best possible management practices are being used.

Comment: The general aim is to keep oxidizing conditions to a minimum. An aeriated organic soil will dissipate and there seems to be no way to prevent it.

Management practices that tend to keep subsidence at a minimum include the following:

1) When the land is idle, keep the water table at the surface or just below.

2) Keep the water table as shallow as possible comenserate with the cropping system.

3) Use minimum tillage. Manipulation of the soil enhances oxidation.

It seems reasonable that subsidence rate should be positively correlated with temperature. However, rates in Florida and Ontario both range from 0.75 to 1.5 inches per year. Subsidence rates in California is reported to be about 2 inches per year.

It needs to 'be established if oxidation dissipation is primarily biological or chemical. If it is biological, there should be a correlation between subsidence and degree-days above biological zero.

7. Need study on fertility and toxicity problems.
Comment: Suggest this be referred to the Agricultural Committee.

SOUTHERN REGIONAL TECHNICAL SERVICE CENTER

All items either covered by Task Force or are included in a continuing activity except for the item on transportation. Transportation is a major problem in mapping organic soils and maybe should be considered by the Organic Committee in the future.

SOIL SURVEY LABORATORY, LINCOLN, NEBRASKA

1. Review the n-value as it relates to the proposal on failure classes for the revised Manual. Consider whether the "liquidity index" (field water content minus Lower Plastic Limit, quantity divided by Plastic Index) should replace n-value.

Comment: Suggest this be referred to the Engineering Committee.

2. Consider whether the concept of water yield coefficient (Boelter has done work on) would be a useful number for interpretations.

Comment: Suggest this be referred to Committee on Soil Moisture and Soil Consistence.

3. Evaluate research on the use of Histosols as filter fields for sewage disposal. Dr. Berdanier should be the coordinator on this.

Comment: Suggest that a Committee be formed to evaluate and assemble information on this subject. This past ASA meeting Dr. Farnham presented a paper on the "Use of Organic Soils for Wastewater Filtration." This paper will be published as a part of the organic symposium.

SOIL SURVEY LABORATORY, BELTSVILLE

All items covered or are a part of work underway.

NORTHEAST REGIONAL TECHNICAL SERVICE CENTER

All items covered or are a part of work underway.

ACREAGE OF ORGANIC SOILS IN THE UNITED STATES*

September 1972

MIDWEST REGION

State	Acreage of Organic Soils
Illinois	104.400
Indiana	3751000
Iowa	117,944
Kansas	0
Michigan	4,529,845
Minnesota	6,377,000
Missouri	4,000
Nebraska	1,000
North Dakota	1,000
South Dakota	0
Wisconsin	2,831,232
TOTAL	14,341,421

SOUTH REGION

state	Acreage of Organic Soils
Alabama	115,000
Arkansas	0
Florida	3,000,000
Georgia	430,000
Louisiana	1,800,000
Mississippi	75,000
North Carolina	1,200,000
Oklahoma	0
South Carolina	75,000
Tennessee	0
Texas	10,000
TOTAL	6,705,000

NORTHEAST REGION

state	Acreage of Organic Soils
Connecticut	100,500
Delaware	3,890
Kentucky	0
Maine	771,765
Maryland	21,547
Massachusetts	346,870
New Hampshire	151,044
New Jersey	113,200
New York	648,079
Ohio	122,500
Pennsylvania	39,071
Puerto Rico	22,208
Rhode Island	23,700
Vermont	60,000
Virginia	312,328
West Virginia	1,500
TOTAL	2,738,222

WEST REGION

State	Acreage of organic Soils
Alaska	27,000,000
Arizona	0
California	166,000
Colorado	10,000
Hawaii	406,460
Idaho	13,600
Montana	110,000
Nevada	2,000
Oregon	67,000
New Mexico	0
Utah	4,500
Washington	200,000
Wyoming	5,500
TOTAL	28,065,060

TOTAL ACREAGE OF ORGANIC SOILS IN THE UNITED STATES - 51,849,703

* Acreage of organic soils obtained from Regional Technical Service Center and compiled by William E. McKinzie, Assistant Principal Soil Correlator, Midwest Region.

A SUITABILITY GROUPING OF ORGANIC SOILS FOR AGRICULTURE

(TENTATIVE - FOR REVIEW AND COMMENT)

Assumptions

1. Suitability ratings for drained conditions assumes continued subsidence rates of 3/4 inch to 2 inches annually; hence for continous use the thicker organic materials are the most suitable.

2. The organic suitability grouping is an interpretative classification designed to assess the limitation of individual organic soils to development for and production of crops.

3. Good soil management, including drainage, control of subsidence, wind erosion, crop growing and conservation practices that are feasible under a mechanized system of agriculture are assumed.

4. The soils within a suitability class are similar with respect to the degree of soil limitation but not necessarily similar with respect to the kind of limitation. The subgroup provides information on the kind of limitation or hazard and the group indicates the intensity of the limitation. Organic soils in group 1 have the least number of soil limitations and group 7 have the most severe.

5. Organic soils which have been reclaimed and developed for agriculture are classified according to any continuing limitations which may affect the production of agricultural crops. Soils in the natural state will be classified not only for the agriculture capability but also will be classified according to the apparent degree of difficulty in reclamation and development.

6. The location, distance to market, efficiency of transport, financial state of the market, farm size and sociological influences do not constitute criteria for suitability groupings.

7. Suitability groupings, suitability definitions and penalty figures are subject to change as new information and methods concerning the manipulation of organic soils become available.

A SUITABILITY GROUPING OF ORGANIC SOILS FOR AGRICULTURE*

A. Physical Features Used To Determint Organic Suitability Grouping.

Factor	Penalty Factors
SOIL TEMPERATURE	
Isohyperthermic	0
Isothermic	0
Hyperthermic	0
Thermic	0
Mesic	0
Isomesic	0
Frigid	25
Cryic	60
Pergellic	90
WATER CONTROL	
Adequate	0
Marginal	35
None	55
COARSE FRAGMENTS (Wood >4" dia.) (Volume % within depths of 51")	
41%	0
1-5%	20
> 5%	50
MINERAL OR LIMNIC LAYERS (Thickness within depths of 51")	
< 2"	0
2-12"	20
SALINITY (mmhos/cm) (Water at 5 cm tension)	
0-4	0
4-8	20
8-16	50
>16	75
WOOD LAYERS (Thickness within depths of 51")	
<3"	0
>3"	20

* This proposed grouping of organic soils follows "A Guide For Capability Classification of Organic Soils", prepared by the Dept. of Soil Science. Ontario Agricultural College, University of Guelph, Guelph, Canada.

Factor	Penalty Factors
THICKNESS OF ORGANIC MATERIALS	
> 72"	0
52-72	10
36-52	20
< 36	40
UNDERLYING MATERIALS (Within depths of 51")	
Loamy	0
Clayey	10
Sandy	20
Diatomaceous earth	20
Coprogenous earth	25
Marl	30
Skeletal	40
Rock or fragmental	50
SULPHUR (Weight % within 40")	
< 0.4	0
0.4-.75	50
> 0.75	75
SLOPE (Percent)	
< 6	0
6-12	20
> 12	50

B. Organic Suitability Grouping.

The ten soil features under A above have penalty values assigned to each subdivision of the soil feature. As a guide to proper suitability grouping, add up the penalty numbers for the soil features applicable and subtract this figure from 100. Using this figure. determine the suitability grouping from the guide below:

SUITABILITY GROUPS FOR AGRICULTURE

1	85-100
2	70-80
3	55-65
4	40-50
5	25-35
6	10-20
7	0-10

Organic Soil Groups

Group 1 (85-100) -- Organic soils of this group have no water, topographical or pH limitations, and are deep and level. They are located in areas having mesic or warmer soil temperatures.

Group 2 (70-80) -- Organic soils in group 2 have one limitation which restricts their use in a minor way. The limitation may be soil temperature, coarse fragments, wood layers, salinity depth or slope.

Group 3 (55-65) -- Organic soils in this group have moderately severe limitations that restrict the range of crops or that require special management practices.

Group 4 (40-50) -- Organic soils in this group have limitations which severely restrict the range of crops or which require special development and management practices.

Group 5 (25-35) -- Organic soils of this group have severe limitations that restrict the production of perennial forage or other specially adapted crops. Large scale reclamation is not feasible.

Group 6 (10-20) -- Organic: soils in group 6 are capable of producing only indigenous crops and improvement practices are not feasible.

Group 7 (Less than 10) -- Organic soils of this group have no potential for agriculture.

Organic Subgroups

Subgroups may be designated as needed to indicate the kind of limitation. For example, if the only limitation a soil had was climate, a designation of 2c could be used or if depth was the limiting factor 2d or 3d could be used to indicate that depth was the limitation.

Explanation of Soil Features

SOIL TEMPERATURE -- refers to the soil temperature classes as defined in Soil Taxonomy.

WATER CONTROL -- refers to ground water level and flooding.

Adequate: Water control system must provide drainage for optimum-crop yields and a water table sufficiently high to prolong the life of the soil.

Marginal : Water control less than adequate. Yields reduced because of poor water control. and choice crops reduced,

None: No control measures for control of groundwater or flooding.

MINERAL LAYERS -- refers to soils in Fluvaquentic or Limnic subgroups and soils having Fluvaquentic or Limnic characteristics included in other subgroups as defined in Soil Taxonomy. This soil feature is not used in rating soils with mineral or limnic layers greater than 12 inches thick within depths of 51 inches. (Terric subgroups or Limnic subgroups with Limnic layer greater than 12 inches thick).

THICKNESS OF OKGANIC MATERIAL -- penalties for thinner soils are related to the eventual destruction of the resource by subsidence.

UNDERLYING MATERIALS -- refers to soils in lithic, limnic, or terric subgroups where the underlying materials are greater than 12 inches thick and soils in terric subgroups that have fragmental or sandy or sandy-skeletal particle-size classes. Penalties for underlying material are related to reclamation as the organic soil subsides and is destroyed.

Development Difficulty Rating*

It is possible that two separate soils may have similar suitability ratings for agriculture but one may be more difficult to reclaim than the other. A development difficulty rating from 1 to 3 is proposed for all organic soils in an unreclaimed state. Brief definitions of the development difficulty groups follow:

Group 1 -- only minor reclamation is required. Minor reclamation is considered to be those operations which can be carried out by a single operator.

Croup 2 -- major reclamation is required but is warranted when soils potential is high. Major reclamation is ttrat requiring cooperation between adjoining operators or outside financial assistance or both.

Group 3 -- major reclamation is required and seldom warranted.

*This Development Difficulty Rating follows the system prepared by the Department of Soil Science, Ontario Agricultural College, University of Guelph.

Physical Features Used to Determine Development Difficulty Rating*

Vegetative Cover	Excess Water And Flooding	Surface Roughness
0 - Light (grasses, reeds, etc.)	0 - None	0 - None
20 - Moderate (Brush, small trees)	35 - Frequent	35 - Holes and mounds, 1-2 ft.
35 - Heavy (numerous large trees)	65 - Extreme	50 - Holes and mounds, > 2 ft.

Coarse Fragments
(Wood > 4" diameter volume % within depths 51")

0 - < 1%
20 - 1-5%
50 - > 5%

Wood Layers
(Thickness within depths of 51")

0 - < 3"
20 - > 3"

Underlying Materials
(within depths of 51")

0 - Loamy
10 - Clayey
20 - Sandy
20 - Diatomaceous earth
25 - Coprogenous earth
30 - Marl
40 - Skeletal
50 - Rock or fragmental

To determine the development difficulty group add up the penalty numbers for the features applicable and subtract this figure from 100. Using this figure, determine the group from guide below:

Group 1	> 55
Group 2	40 - 50
Group 3	< 50

Recommendations for site development should be based on both the development difficulty rating and the suitability grouping for the soil after development.

*Physical features used and penalty figures assigned are subject to change as new methods and more information as result of testing becomes available.

TENTATIVE

FOR REVIEW AND COMMENT

1

Guide Sheet 1 Suitability ratings of Soils as 5/ Onions, carrots, radishes, parsnips, cole crops, sugar cane, celery, lettuce, spinach, etc. and for ~~production of sod.~~

Item affecting Use	Degree of Soil Suitability		
	Good	Fair	Poor
Climate	Mesic Hyperthermic 1/	Thermic Frigid	Cryic
Depth of Organic Materials	>51"	36"-51"	<36"
Reaction 2/ Ph	5.0 - 6.0	4.0 - 5.0 6.0 - 7.0	<4.0 >7.0
Depth to Water 3/	28 - 32"	32 - 36 24 - 28	<24" or >36"
Underlying Mineral Materials	Loamy	Clayey, sandy, diatomaceous	Marl, bedrock, skeletal
Woody Fragments > 4" diameter	<1%	1 - 5%	>5%
Salinity 4/	0-4 mmhos/cm	4-8 mmhos/cm	8-16 mmhos/cm
Degree of Decompostion	Sapric or Hemic	Fibric	--
Sulphur	None	None	None
Mineral Layer (2 - 12" thick)	None	36 - 51"	16-36"

1/ Winter only

2/ Reaction may be controlled to a degree through the use of lime or sulphur.

3/ Maximum depths

4/ Some adjustment for variable crop tolerance may be necessary.

5/ Suitable for frost susceptible crops. (Corn, beans, and cucurbits, etc., with proper climatic conditions).

TENTATIVE

FOR REVIEW AND COMMENT

Guide Sheet 2 Suitability rating of Soils for Cranberries[2]

Item affecting Use	Degree of Soil Suitability		
	Good	Fair	Poor
Climate	Mesic	Frigid	Warmer than mesic
Depth of Organic Materials	> 51"	36 - 51"	< 36"
Underlying Material	Sandy	--	--
Reaction (Ph)	3.0 - 4.0	4.0 - 4.5	> 4.5
Depth to Water 1/	0 - 20"	--	> 20"
Woody fragments	< 1%	1 - 5%	> 5%
Decomposition	Fibric or Hemic	--	--

Footnotes - Remarks

1/ Water control essential to include flooding.

Organic Soils Task Force Meeting
St. Paul, Minnesota
November 27-December 1, 1972

Report of the Committee on Forestry

The forestry committee met on Wednesday and Thursday, November 29, 30, 1972, principally to discuss interpretations for organic soils as used for the production of forest products.

Two rating systems were developed and are outlined here. One is based strictly on productivity. The other system outlines use potential groups based on ratings assigned to selected indicator properties.

Productivity Classes

Productivity is rated in cubic feet produced per acre per year, in terms of merchantable stands for pulp or other use with a higher economic return. The minimum acceptable size is an 8-foot log with 4-1/2 inch base diameter and It-inch top diameter.

Class	Estimated yield cu.ft. acre year
1	> 100
2	60-100
3	30-60
4	10-30
5	< 10

Classes were based on data from:
- Silvics of North American Trees
- Preliminary Draft Michigan Ordination of Soil Series
- Soil Series Interpretations Sheets
- Partial Summary of Measurements of Site-index of Several Trees on Histosols of Minnesota
- Miscellaneous publications of U.S.F.S. and Michigan Universities

Use Potential Groups for Forestry on Organic Soils

The table (pg. 21) outlines use potential. groups for forestry sites based on each of several indicator properties. The overall rating for the site corresponds to the most limiting case found from assigning the individual ratings. For instance, a site on a 30 percent slope that is otherwise excellent is placed in Group 3. A site on a 30 percent slope with bedrock at less than 10 inches hut otherwise excellent is also placed in Group 3. The same criteria are applied to drained and undrained sites.

A series of penalty factors (see page 21) were assigned to selected indicator properties and used as a tool to outline the Use Potential Groups. The penalty factors do not relate directly to the Use Potential Groups as adopted, and are not used in computing a rating for the soil.

The Use Potential Groups and the Productivity Classes were tested through analysis of' three thermic, one mesic, and three frigid soils. Series included Allemands, Pamlico, Washkish, Moose Lake, Caron and Beseman. All keyed out satisfactorily in the system. A worksheet for the Beseman series is attached.

The Forestry Committee would like to have the system of Productivity Classes and Use Potential Groups reviewed by appropriate persons in universities, colleges, the U.S. Forest Service and the U.S. Soil Conservation Service. It is hoped that comments and suggestions for modification can be returned to the Forestry Committee for evaluation before a working system is put out for trial.

Respectfully submitted,

The Forestry Committee:
Edwin Neumann, Chairman
D. Boelter
H. R. Finney
S. Rieger
Steven Shetron
R. E. Smith

Forestry

Relative penalty ratings for individual factors that bear upon forestry production. The lower the number, the better the site. The penalty ratings were used as a tool to arrive at the Use Potential Groups, but are not used to compute suitability ratings in the system adopted.

Factor	Penalty
1. Soil Temp. (climate)	
Hyperthermic	0
Thermic	10
Mesic	30
Frigid	50
Cryic	65
Pergelic	80
2. Water Table (controlled-uncontrolled) in growing season	
depth to	
0-6"	50
6-18"	20
18-30"	0
> 30"	20
3. Reaction in Root Zone (0.01M $CaCl_2$)	
< 4.5	30
4.5-7.0	0
> 7.0	20
4. Salinity mmhos/cm	
Water at 5cm tension	
0-4	0
4-8	20
8-16	50
> 16	75
5. Depth to Bedrock	
> 16"	0
10-16"	20
5-10"	30
< 5"	40
6. Sulfur (Wt. % within 1 meter)	
< 0.4%	0
> 0.4%	100
7. Flooding	
Prolonged flooding in growing season will cause serious damage or death. No ratings assigned.	
8. Slope	
< 25%	0
25-45%	20
> 45%	50
9. Surface Tier	
Discontinuous or no sphagnum	0
Continuous sphagnum	20

Use Potential Groups for Forestry

FACTORS	GROUPS				
	1	2	3	4	5
Temperature Regimes	Hyperthermic Thermic	Mesic*	Frigid*	Cryic*	Pergelic
Water Table in Growing Season	------------18-30"----------		6-18" > 30"	0-6"	
Reaction in Root Zone (CaCl)	4.5-7.0	> 7.0		< 4.5**	
Salinity	0-4mmhos/cm	4-8mmhos/cm		8-16mmhos/cm	> 16.0mmhos/cm
Sulfur	none	< 0.4%			> 0.4%
Depth to Bedrock	> 16"	10-16"	5-10"	< 5"	
Slope	0-25%		25-45%		> 45%
Composition of Surface Tier	Discontinuous Sphagnum		Continuous Sphagnum		
Underlying Material Other than Bedrock	Use agricultural criteria if drained; not significant if not drained				

* High rainfall maritime climate to be rated one class higher.
** This pH does not apply to maritime climates with > 70" annual precipitation.

Use Potential Groups for Forestry on Organic Soils

Series: [illegible] Phase:

Classification: Terric Borosaprist, loamy, mixed, dysic

For Production of: Black spruce for pulp

Factors	Reclaimed	Native or Unreclaimed	Remarks
	GF	P	
Temperature		3	
Depth to water		3	
Reaction		4	
Permafrost		-	
Salinity		1	
Decomposition		1	
Sulfur acidity		1	
Suitability rating for site		4	

Yield: 10 to 30 cubic feet/acre/year

Site Index: 10 to 30

Committee on Engineering Interpretations
National Task Force on Organic Soils
St. Paul, Minnesota
November 27 - December 1, 1972

Members: John Day, Soils Research Institute, Ottawa, Canada; Guy H. Earle, Jr., SCS, East Lansing, Michigan; R. S. Farnham, Univ. of Minn., St. Paul, Minnesota; Warren Lynn, SCS, MRTSC, Lincoln, Nebraska; K. C. Hinkley, SCS, Batavia, Illinois; D. F. Slusher, SCS, Alexandria, Louisiana (Chairman).

The committee on engineering interpretations met for two days during the National Task Force on Organic Soils Workshop, November 27 - December 1, 1972. The committee evaluated soil survey interpretations form SCS-SOILS-5 (Rev. May 1972) to determine its suitability for recording features of organic soils. In addition, they developed a numerical rating of soil limitations for engineering purposes to be considered further and tested.

The committee report is as follows:

Soil Survey Interpretations Form (SCS-SOILS-5, Rev. May 1972)

Many qualities and properties of organic soils, important in all soil survey interpretations, are also important in mineral soils. Permeability, available water capacity, reaction, salinity, and corrosivity are examples. In addition, some organic soils contain mineral layers within organic layers. Others are underlain at relatively shallow depths by mineral layers. Where organic soils contain mineral layers the USDA texture, engineering classes, particle size, liquid limit and plasticity index must be considered in making engineering interpretations. For these reasons the committee recommends that a single form (SCS-SOILS-5) be used for both organic soils and mineral soils. The form, however, needs to be modified to adequately record features of organic

soils and some additional properties of mineral soils such as Hydraquents. *Estimated properties of mineral layers in organic soils should be recorded in the same way as in mineral soils.

Suggested modifications of form SCS-SOILS-5 under "Estimated Soil Properties" are as follows:

AASHO - Some states designate organic soil materials as class A-S, however, this class is not defined in the PCA Soil Primer. It is suggested that the American Association of Highway Officials be contacted to determine whether or not A-S is an approved designation and if so what is the definition. If A-E is an approved definition, SCS offices should be notified to use it.

Fraction greater than 3 in. (pct) - That this column be designated as a place to record hard wood fragments greater than 3 inches in the shortest dimension as a volume percent (as 20 wood) in organic layers or mineral layers of Hydraquents. Present conventions for recording rock fragments in mineral or organic soil layers would be continued.

Percent of material less than 3 in. passing sieve - That these columns be used to record 2 mm. to 3 inch size rock fragments, as appropriate, in organic soil layers.

Liquid Limit and Plasticity Index - Not applicable for organic soil layers. Use for mineral layers of organic soils.

Permeability - That permeability be recorded for organic soil layers just as it is in mineral layers. Available data needs to be analyzed and general guides be furnished field offices for use in making estimates.

Available Water Capacity - That available water capacity be estimated for organic soil layers, just as it is for mineral layers. Available data needs to be summarized and guides for estimation be prepared for use in the absence of data.

Soil Reaction (pH) - That this column be designated for use as $CaCl_2$ pH if the layer is organic.

Shrink-Swell Potential - Not applicable to organic layers.

Subsidence (initial-in.) - It is recommended that this column be moved and initial subsidence rated by soil layers in terms of inches per inch for organic soil layers and mineral layers with n-values greater than 0.7. The soil survey investigations people should be asked to set a standard minimum moisture content that might be achieved on drainage and prepare guidelines for making estimates of initial consolidation and shrinkage of undrained materials. Since total initial subsidence is a function of the kind and thickness of materials as well as depth of drainage, a single value (whole soil) for initial subsidence is not practical.

Subsidence (Total-in.) - That total subsidence be rated for the whole soil for the entire thickness of organic layers. Total subsidence includes initial subsidence due to drainage and subsequent subsidence due to oxidation of the organic material. Ratings might be given by classes or a range of inches or feet. Classes proposed for use are given on page 30 ., however, modification is needed to apply to subsidence of pergellic soils.

Additions to SCS-Soils-5

1. Potential sulphur acidity - This value is suggested as pH value, by horizons or layers, that might result from drainage and oxidation of sulphides. It should reflect potential acidity and not be restricted to soils with sulphidic soil materials as defined by Soil Taxonomy. Soils already drained, with low pH values already present, would not be recorded in this column.

2. Trafficability - Three classes are proposed for use on a whole soil basis for Histosols and Hydraquents to indicate whether the soil is too soft for cattle to graze, firm enough for cattle to graze, or borderline between grazable and not grazable. The term "trafficability" may not be appropriate since it may imply vehicular to some.

3. N-value - This value should be added and given by soil layers. Classes need to be developed. It must be kept in mind, however, that n-value does not apply to organic layers.

Engineering Interpretations

The committee felt that mineral soils and organic soils had many properties and qualities in common that were important to engineering use. Among these are depth to water table, depth to rock, flooding, slope, permafrost, salinity, permeability and others. Although organic matter content of organic soils presents special problems in engineering, so do many properties of mineral soils. It was concluded that the real need was for a single rating system for engineering Purposes that would rank both mineral and organic soils to facilitate comparisons. Rating systems developed only to compare organic soils one with another would have limited practical value.

On the basis of the foregoing conclusion the committee directed its efforts toward a rating system that would be applicable to all soils. Dwellings with basements was selected for trial. A system of values (penalty points) was developed so that each significant soil factor was considered. Soil factors included in "guide sheet 6, soil limitations for dwellings" in the Guide for Interpreting Engineering Uses of Soils, November 1971, were used in addition to those considered unique Lo organic soils,

Penalty values were assigned for each item or combination of items affecting use (page 31) . Each soil is rated in accordance with the applicable factors and the penalty values totaled. Soils with the lowest total penalty value have the fewest limitations and consequently the best suitability for the rated use. Only a few soils were rated (page 32). Additional ratings of many soils are needed Lo test the system. Additional items may need Lo be added for rating - such a:; n-value. Revision of the penalty values will no doubt be needed to achieve rankings considered valid. Classes within items affecting use may also need revision. If the Penalty value approach is proven successful, values for other uses can he developed.

After the system is developed, then classes such as slight, moderate, severe, or very severe can be based upon quantitative values. For example ratings of 0 to 35 might be rated as soils with slight limitations, 35 to 100 as moderate limitations, 100 to 200 as severe limitations, and more than 200 as very severe limitations. The advantage of the proposed system is that heavy penalties are assigned for items that are nearly impossible to overcome without great cost. Items such as shrink-swell that are relatively easy to overcome by design are penalized less.

Recommendation: The committee recommends that the proposed system be tested and developed further for dwellings with basements. If proven successful a similar system for other engineering uses is urged.

CRITERIA FOR RATING SOILS FOR SUBSIDENCE POTENTIAL

Subsidence potential refers to the maximum possible loss of surface elevation from organic soils or soils with semifluid mineral layers. Estimates are made as to changes that take place as a result of drainage and oxidation, or oxidation alone if the soil has already been drained. This does not take into account geological subsidence. Subsidence of organic soils after drainage is attributed mainly to four factors: (1) loss of groundwater buoyancy, (2) consolidation, (3) compaction, and (4) biochemical activity. Elevation loss due to the first three factors is termed initial subsidence and is normally accomplished in about three years after lowering the water table. Initial subsidence of organic soils will typically result in a reduction of thickness of the organic materials above the water table by about one-half. After initial subsidence, shrinkage will continue at fairly uniform rate due to biochemical oxidation of the organic materials. This is termed continued subsidence and will progress until mineral material or the water table is reached. The rate of continued subsidence depends upon the depth to water table and increases with depth to water table.

Soils with semifluid mineral layers will have initial subsidence due to loss of water and consolidation after drainage and will have little if any subsidence thereafter.

Subsidence of organic soils can be stopped by maintaining the water level at the surface. It can be slowed by maintaining the water level as high as possible for the land use. Four subsidence potential classes are to be used in making soil interpretations.

Subsidence Potential as a Result of Drainage

Class	Subsidence Potential (Inches)	Soils
Low	0 to 3	(1) Mineral soils with organic surface accumulations 0 to 3 inches thick. (2) Mineral soils with semifluid layers (greater than 100 percent saturated with water).
Medium	3 to 16	Mineral soils with organic surface accumulations 3 to 16 inches thick.
High	16 to 51	Organic soils with organic accumulations 16 to 51 inches thick.
Very High	Greater than 51	Organic soils with organic accumulations greater than 51 inches thick.

ENGINEERING INTERPRETATIONS
For Small Buildings with Basements

LIMITING FACTORS AND RATINGS

DEPTH	ORGANIC (Including Limnic) OVER- Rock	Frag. Skel. Rippable Bould.	Sandy Sediments GP,GW,SP SW,SC,SM CL/PI<15	Clayey Sediments or Platy Rock CH,MH	Loamy Sediments ML CL/PI>15	MINERAL OVER- Rock	Frag. Skel. Rippable Bould.
< 1m (<40")	200	140	100	90	80	80	50
1-1.5m(40-60")	200	160	130	120	110	50	20
1.5-3m(5'-10')	180	180	160	150	140	20	0
3-6m(10-20')	200	200	180	170	160	10	0
> 6m (>20')	200	200	200	200	200	0	0

<-- One or Other -->

SEASONAL HIGH WATER TABLE

(Depth)	
< 75cm (<30")	80
75-150cm(30-60")	40
>150cm (>60")	0

SOIL DRAINAGE

Excessive, Somewhat excess., Well	0
Mod. well	40
Somewhat poor, Poor, Very poor	80

FLOODING

Percent Probability	
None	0
0-2%	50
2-10%	100
>10%	200

FROST ACTION

GW,GP,SW,SP	0
GM,GC,SC,CH,OH	5
ML,CL,OL,MH,SM	10

PERMAFROST

(Depth)	
None	0
<1-5m(<5')	70
1.5-3m(5-10')	50
3-6m(10-20')	35

ROCKINESS

(Percent outcrop)	
<2%	0
2-10%	20
>10%	40

STONINESS

(Mineral soils only) (Aerial percent)	
<0.1%	0
0.1-3%	15
>3%	30

SLOPE

(Percent)	
0-8	0
8-15	30
15-30	60
30-60	100
>60	150

SHRINK-SWELL

(Mineral layers only) (con:)	
<0.03	0
.03-.06	5
.06-.09	10
>.09	20

UNIFIED CLASS

(Mineral soils only)		
SANDY	GW,GP,SW,SP GM,GC,SM,SC CL/PI<5	0
LOAMY	ML,CL/PI>15	25
CLAY	CH,MH,OL,OH	50

WOOD

(Layers, logs, stumps) Aerial frequency within 3 m	
None	0
0-3	45
>3	90

RATING CHART FOR ENGINEERING INTERPRETATIONS

USE: Small Buildings with Basements

SOIL	PENALTIES											RATING
	DEPTH	WATER TABLE OR DRAINAGE	FLOODING	FROST ACTION	PERMA-FROST	ROCKINESS	STONINESS	SLOPE	SHRINK-SWELL	UNIFIED	WOOD	
Fairhaven, 0-6% slope Typic Hapludoll fine-loamy, mixed, mesic	0	0	0	0	0	0	0	0	0	0	NA	0
Fairhaven, 6-12% slope Typic Hapludoll fine-loamy, mixed, mesic	0	0	0	0	0	0	0	30	0	0	NA	30
Fulda (not flooded) Typic Haplaquoll fine, montmorillonitic, frigid	0	80	0	10	0	0	0	0	10	25	NA	125
Sharkey Vertic Haplaquept very fine, montmorillonitic, thermic	0	80	0	0	0	0	0	0	20	50	0	150
Delcomb (drained) Terric Medisaprist loamy, mixed, euic, thermic	80	80	50	0	0	0	NA	0	5	NA	0	215
Lobo (rock at 2 m) Hemic Sphagnofibrist dysic, frigid	180	80	0	0	0	0	NA	0	NA	NA	0	260
Lobo (deeper than 6 m) Hemic Sphagnofibrist dysic, frigid	200	80	0	0	0	0	NA	0	NA	NA	0	280
Delcomb (undrained) Terric Medisaprist loamy, mixed, euic, thermic	80	80	200	0	0	0	NA	0	5	NA	0	365

ORGANIC SOILS TASK FORCE MEETING
St. Paul, Minnesota
November 27-December 1, 1972

Report of Committee on Wildlife

The committee on wildlife met only for about one hour on November 30, 1972, to consider interpretations of organic soils for wildlife habitat. The reason for the short meeting was because the participants were on other committees whose work seemed to be of higher priority. During our meeting we considered briefly the philosophy of interpretations for wildlife as well as Soils Memorandum-74 (January 20, 1972)--Soil Interpretations for Wildlife Habitat. Our recommendations follow:

1. More emphasis should be placed on relationships between wildlife or wildlife habitat and soil associations rather than soil series and phases of soil series. The latter seems to be the approach used in Soils Memorandum-74.
2. In regard to Soils Memorandum-74, we recommend the following:
   a) Ratings for grain and seed crops and for domestic grasses and legumes on organic soils should be based primarily on the classes for crop production that have been devised during this meeting.
   b) We challenge the ratings for hardwood trees and coniferous plants because the better soils are rated highest. We think the poorer soils may well be better for producing this kind of wildlife habitat.
3. Suitability ratings for special uses such as for construction of dikes, production of open-water areas by using explosives, etc. should be developed.
4. A committee be designated to further study and to develop guidelines for making interpretations on wildlife habitat on organic soils and integrating such interpretations with interpretations for mineral soils. The committee might consist of:
   a) One SCS biologist from each SCS region.
   b) One or more biologists from State Departments of Natural Resources.
   c) One or more biologists from the Forest Service and/or the Fish and Wildlife Service.
   d) Soil Scientist.

   Incidentally, John Bedish, Biologist, SCS, St. Paul, Minnesota agreed to chair such a committee. We also recommend that John Mathison, Biologist, Forest Service, Chippewa National Forest, Cass Lake, Minnesota be on this committee.
5. The present committee on wildlife formed by this task force should be discontinued.

Committee for Task Force:
II. R. Finney (Chairman)
D. F. Slusher
S. Rieger

Other Participants
R. E. Smith
E. Neumann
S. Shetron

TASK FORCE ON ORGANIC SOILS

COMMITTEE ON COMMERCIAL USES OF PEAT

COMMITTEE MEMBERS:

Warren Lynn	S.C.S., Lincoln, Neb.
John Day	Canada Dept. of Agric. Ottawa
R.S. Farnham (chm.)	Univ. of Minn.

The above committeee met informally during the week of Nov. 22 - Dec. 1, 1972 and it was decided that the chairman would prepare a summary of the activities regarding establishing of standards for classification, sampling and testing commercial peat by the A.S.T.M. (Amer. Society for Testing & Materials, Philadephia). A.S.T.M. Committee D-29 on Peats, Mosses, Humus, and related products was organized in 1963 and subcommittees have subsequently worked on classification, analyses and testing procedures for peat products. A standard classification of peats, mosses, humus and related materials was approved and became effective in April 1969 (A.S.T.M. designation D 2607-69). A summary of this specification (designation) is as follows:

A definition of the material is given so as to exclude coal, lignite, bark and other non-peat organic materials. Fibers are defined as material retained on an A.S.T.M. No. 100 mesh sieve (0.15 mm) and less than (0.5)inch. Classification of materials Include kind and amount of fibers of a specific kind; such as

Sphagnum Moss Peat (Peat Moss)
Hypnum Moss Peat
Reed-Sedge Peat
Peat Humus
Other Peat

The above standard is advisory only but probably will be adopted by U. S. Government (G.S.A., Navy Dept., etc.) to be used in writing specifications for use on grounds at government installations.

New standards approved by A.S.T.M. D-29 committee include the following:

D2973-71 Test for total nitrogen in peat materials.
D2974-71 Test for moisture, ash, and organic matter.
D2975-71 Test for sand content of peat
D2976-71 Test for pH of peat materials.
The above is a pH test using 0.01M calcium chloride solution (salt solution pH).
D2977-71 Test for particle size range of peat materials.
D2978-71 Test for volume of peat materials is measurement of the volume of loose and baled peat expressed in cubic feet.
D2980-71 Test for volume weight, water holding capacity, and air capacity of water saturated peat materials.

Canadians are members of these A.S.T.M. subcommittee and therefore we have their imputs. This Is because Canada exports all its peat moss to the U.S. In addition, there is a committee of the Intl. Peat Society which is working on international standards for commercial peat. We are kept informed of their activities and Progress and they have copies of our A.S.T.M. standards.

Organic Soils Task Force Meeting
St. Paul, Minnesota
November 27-December 1, 1972

SOIL TAXONOMY

Since most of the participants were actively associated with soil taxonomic matters, the opportunity was taken to obtain their reactions to several proposed changes in Soil Taxonomy. A total of 2-1/2 hours of conference time was utilized. Copies of the proposals were distributed Monday afternoon. Each participant receive? duplicate copies of each proposal, fixed to make carbon copies. An hour was allowed Wednesday morning for oral comments, questions, and discussion. Carbon copies of written comments were returned to the meeting secretary who compiled the comments and reactions. An hour was allowed Thursday afternoon for discussion and to indicate recommended disposition of each proposal. The following list of the proposals is categorized according to the recommended disposition.

I. Proposals recommended for immediate incorporation into Soil Taxonomy. Ii' the changes are deemed too extensive to be incorporated prior to publication, they should be considered for the first revision of the published Soil Taxonomy.

1. Proposal: Estimate fiber percentages in field descriptions based on the volume of soil material. The present directions are to use the organic volume as a base.
   Reason: In practice organic volume and total volume are the same.
   Recommendation: Immediate incorporation. State that estimates be made on soil volume excluding coarse fragments and mineral layers.

2. Proposal: Drop Unrubbed Fiber as a definitive criterion for histic materials at the Suborder level.
   Reason: Rubbed fiber is a better indicator of degree of decomposition than unrubbed fiber. Unrubbed fiber is misleading in many cases because "ghost fibers" give impression of less decomposition than is actually the case. No reliable test procedure has been developed for unrubbed fiber.
   Recommendation: Immediate incorporation.

3. Proposal: Drop the special definition of cryic temperature regime for Histosols and use the definition presently used for mineral soils. (Drop cryic definitions for organic soils, pages 3-61, Soil Taxonomy, and utilize definitions employed for mineral soils--same page.)
   Reason: Eliminate dual system.
   Recommendation: Immediate incorporation.

4. Proposal: Drop Clastic Families.
Reason: Distinction between clastic and non-clastic families cannot be made reliably by field observations. Reasonable need for the distinction cannot be derived from theory or demonstrated in practice.
Recommendation: Immediate incorporation.

5. Proposal: Add Terric Subgroups to Great Groups of Sulfihemists and Sulfohemists.
Reason: A practical need has been expressed by personnel in the northeast region.
Recommendation: Immediate incorporation.

II. Proposals recommended for incorporation at the series or phase level.

6. Proposal: Add a Sphagnic Subgroup in Great Groups of Cryohemists and Borohemists.
Reason: Sphagnic layers on the surface of a hemist would markedly affect plant growth and should be flagged.
Recommendation: Handle as phase.

7. Proposal: Separate organic soils with significant proportions of logs or stumps.
Reason: Presence of logs or stumps bears significantly upon use and management.
Recommendation: Incorporate at series or phase level.

8. Proposal : Add a subgroup of Lithic Terric Medisaprists. Define as Medisaprists like typic except for f and c and the lithic contact is below the subsurface tier.
Reason: A mineral layer greater than 30 cm thick above a lithic or paralithic contact is significant to use and management, and should be recognized at the subgroup level.
Recommendation: Handle as series or phase as needed.

III. Proposals viewed favorably but should be tested, reviewed and reconsidered for incorporation into Soil Taxonomy.

9. Proposal: Place the base of control section for all Histosols at a depth of 160 cm.
Reason: Canadian experience indicates knowledge of the material to a depth of 5 or 6 feet is necessary to make judgements for agricultural use. Mineral soils are characteristically described to a depth of 5 feet, or more. In dividing responsibilities for cataloging the earth's resources, soil science is generally allotted the upper 5 or 6 feet. One set of depths would eliminate the confusion of having a dual system.
Recommendation: Prepare for review.

10. Proposal: Define fibric, hemic, and sapric materials as follows:
   a. A fibric material has 2/5 or more rubbed fiber by volume and a pyrophosphate index of 5 or more. (Pyrophosphate Index is obtained by subtracting the chroma from the value in the Munsell color notation derived from the pyrophosphate solubility test.) If the rubbed fiber volume is 3/4 or more, the pyrophosphate criterion does not apply.
   b. A hemic material is one that fails to meet the requirements for fibric or sapric.
   c. A sapric material has less than 1/6 rubbed fiber by volume and a pyrophosphate index of 3 or less.

Recommendation: Prepare for review.

11. Proposal: Distinguish, taxonomically, materials that are commercially suitable for peat moss, i.e., sphagnum materials with less than 25% mineral content on an oven-dry weight base.

Alternatives:
   a) Make Typic Sphagnofibrists compatible with the above. Flag subgroups that are 25% or more mineral material by weight.
   b) Designate commercially suitable sphagnum materials by phases of series.

Reason: To make our mapping delineations more useful to the commercial peat industry.

Recommendation: Prepare for review. Group suggested alternative (a).

12. Proposal: Include in Sphagnofibrists, soils that have 1/2 sphagnum fibers in the upper 120 cm (surface + middle tiers).

Reason: To group together all soils that are dominantly sphagnum. Identify pure sphagnum materials at the series level.

Recommendation: Prepare for review.

13. Proposal: Drop mineralogy families of Terric Subgroups.

Reason: Several workers are of the opinion that the distinction is not warranted at the family level. A separation can be made at the series level if needed.

Recommendation: Test in field--Kenneth Hinkley will evaluate the need in northern Illinois.

14. Proposal: Consider proposed definition for Hydraquents in SRWPC report--1972. Typic Hydraquent materials should have an n-value greater than 0.7 from 20 to 125 cm.

Recommendation: Prepare for review.

15. Proposal: Modify the definition of Histosols to include soils with half of the upper 80 cm or more formed in coprogenous earth (sedimentary peat). To accommodate these soils add the following Great Groups:

Cryolimnists
Borolimnists
Medilimnists
Tropolimnists

Subgroups would be added as needed. Possible Subgroups might be Terric, Histic, and Thapto-Histic.

Reason: Coprogenous materials have unique properties unlike organic soils or mineral soils and should be recognized separately. Engineers are insistent that coprogenous materials be identified and flagged.

Recommendation: Prepare for review.

16. Proposal: Modify the definition of Entisols to include soils with the upper 50 cm or more formed in marl or diatomaceous earth and to permit these kinds of soils to have a Histic epipedon. To accommodate these kinds of soil, add a Great Group of Limnaquents to the suborder of Aquents. Subgroups would be added as needed. Possibl e subgroups might be Terric, Histic, or Thapto-Histic.

Reason: Marly and diatomaceous limnic materials are mineral by current definitions, and as such do not fit well into Histosols. Their properties are distinct enough to be separated from other Aquents. They would parallel Hydraquents to some extent.

Recommendation: Prepare for review.

17. Proposal : Identify salt (sodium) affected Histosols.

1. Redefine Fibrists in key to suborders to exclude soils having an SAR > 13, (or sodium saturation that is 15 percent or more) in > half of the upper 50 cm.
2. Add to definition of Saprists 2. ----, or 3. have SAR > 13 (or sodium saturation that is 15 percent or more) in more than half of the upper 50 cm; arid 4. do not have a sulfuric horizon that has its upper . . . . etc.
3. Add to key to great groups following Horosaprists.

Other Saprists that have SAR > 13 (or sodium saturation that is 15 percent or more) in more than half of the upper 50 cm--Halasaprists. Typic Halasaprists. At present, only two series of Hal asaprists are recognized. These are the Lafitte and Delcomb series. Typic Halasaprists should be defined to include items a and c of the defintions of Typic Medisaprists. The Lafitte series is of Typic Halasaprists. The Delcomb series is of Terric Halasaprists.

Reason : Salt and/or sodium affected organic soils commonly occur in coastal areas and should be distinguished.

Recommendation : Prepare for review.

IV. Proposals recommended to be dropped.

18. Proposal : Recognize Fluvaquentic Terric Subgroups explicitly. Require mineral bands to be at least 30 cm above the terric contact.

Reason: Mineral bands significantly influence the hydrology and should be flagged in terric as well as typic pedons.

Recommendation: Drop. Situation best handled as now done in Soil Taxonomy.

19. Proposal: Modify the definition of Entisols to allow Hydraquents to have a Histic epipedon.

Reason: Hydraquents commonly have Histic surface layers. There is no alteration of the type associated with cambic horizons, and the soils should not be included with Inceptisols as is presently the case.

Recommendation: Drop. Now included in Soil Taxonomy.

<u>Unused Subgroups of Histosols</u>

H.R. Finney and R. S. Farnham pointed out that a number of subgroups are outlined in Soil Taxonomy for which no series have been defined and proposed that consideration be given to deleting some as all of the unused subgroups. These comments follow:

> "For background, the fact that few series of Histosols had been defined before the development of the classification need special emphasis. Compared to mineral soils very little was known about the extent of the different kinds of Histosols. Most of the subgroups that have been defined (all statements refer to definitions in Soil Taxonomy, Dec. 1970) could logically be expected to exist somewhere but their extent generally was unknown. During the several years that the system has been tested, one might assume that by this time at least one soil series would have been recognized in most all subgroups that have some appreciable extent or significance. However, of the 88 defined subgroups that could logically be expected to occur somewhere in the U.S., named series have been recognized in only 37 of those subgroups (based on Soil series of the United states, Puerto Rico, and the Virgin Islands: Their Taxonomic Classification, Aug. 1972). Perhaps most of the subgroups with no series could be eliminated. Further, in most of the subgroups that do have a named series, many have only one family with named series, and in turn many of these families have only one named series. Thus, some of these subgroups also could be eliminated. Some ways in which subgroups could be eliminated follow.
>
> In regard to the situation where no series have been defined for subgroups, consider for example the Medifibrists. Twelve subgroups of Medifibrists have been defined, but named sol.1 series have been defined in only three subgroups; namely the Typic, Limnic, and Terric. The subgroups with no series are:

Fluvaquentic	Sapric
Hemic	Sapric Terric
Hemic Terric	Sphagnic
Hydric	Sphagnic Terric
Lithic	

Perhaps one can assume that the reasons no series are recognized in these subgroups are that (1) extent is very minor or even nonexistent, or (2) extent may be significant but it does not occur in mappable bodies (occurs in a transition zone between two more important soils), or (3) extent may be significant but is so similar to some other taxon that not much is gained by recognizing it. The differentiae for the Fluvaquentic, Hemic, Hydric, Lithic and Sphagnic subgroups would be eliminated. If such soils were recognized, they would fall within the Typic subgroup, and they would or could be recognized at the series category. This also would eliminate the Hemic Terric, Sapric Terric, and Sphagnic Terric subgroups which in turn would be included in the Terric subgroup.

In regard to mono-series subgroups, consider for example the subgroup of Hemic Borosaprists in which only the Carbondale series has been recognized, The differentiae for that subgroup should be eliminated and such differentiae could be recognized at the series category.

Perhaps some general criteria could be developed for the recognition of subgroups. Chief among the criteria certainly would be extent. We generally recommend that for a series to be named, it must have an extent of at least 2,000 acres. For a subgroup to be recognized perhaps at least something on the order of 5,000 to 10,000 "mappable" acres of that soil should be required. Further, data on hand would have to indicate that more than one series will be recognized In the subgroup. We see little utility in recognizing a subgroup with only one series. The differentiae that specified such a subgroup could be relegated to the series category.

As we see it, in about two years the classification of Histosols would be tested sufficiently for the consideration of major revisions. One of the main objectives of this revision should be a simplification of the classification primarily through the elimination of unneeded or unimportant subgroups. We would hope that the users of the classification of Histosols would consider this as a major objective in improving the classification. Further, we hope the task force on organic soils will seriously consider this facet of the classification in their next meeting."

System Systematics

An objection was raised, in principle, to the taxa of Sulfohemists and Sulfihemists presently in Soil Taxonomy. Sulfur affected Histosols are Hemists, regardless of the state of decomposition. It disrupts the sytem to place "special interests" above the orderliness of the sytem. Sulfur recognition could be handled adequately within each of the established suborders. i.e., Sulfifibrists,Sulfihemists, and Sulfisaprists.

Temperature Classes

John Day pointed out that the U.S. Has two systems of temperature classes: one in Soil Taxonomy and one on the soil climatic map. The latter is a product of the World Soil Map and FAO, and correlates with the scheme used in Canada. Day suggested we get our definitions together, perhaps giving preference to Soil Climatic Map definitions. Apparently the discrepancies are for the colder soils.

Botany arid Fiber Content

Warren Lynn pointed out that the laboratory testing program for fiber content indicated a relationship between state of decomposition and botanical composition. The following table was presented.

Botany / Decomposition (Fiber Content)	Sphagnum	Hypnum	Herbaceous	Woody
Fibric	Yes	?	?	?
Hemic	Yes	Yes(?)	Yes	Yes
Sapric	?	?	Yes	

Lynn asked the group for help in documenting the question marks by sending examples of pertinent material to the laboratory. If the indicated relationship is found to hold true, the only fibrists will be Sphagnofibrists.

Soils: Mineral, Organic, and In-Between

Warren Lynn indicated there is a body of evidence suggesting that soil materials with 65 to 85 percent mineral matter by weight should be considered as a group. In general , soils can be grouped as mineral, organic, and in-between. The in-between group are generally depositional in nature and would include Hydraquents, Sulfaquents, and other soils with soft (unless drained) depositional layers. Andic and Limnic materials may be included. The mineral content should be low enough to exclude subaerial soils as Mollisols and Spodosols.

	Subgroups	With Series	Without Series
FIBRISTS			
Borofibrists	12	3	9
Cryofibrists	6	2	4
Medifibrists	12	3	9
Sphagnofibrists	10	4	6
	40	12	28
HEMISTS			
Medihemists	10	5	5
Cryohemists	5	2	3
Borohemists	10	5	5
	25	12	13
SAPRISTS			
Medisaprists	9	5	4
Cryosaprists	5	3	2
Borosaprists	9	5	4
	23	13	10
TOTAL	88	37	51

NATIONAL COOPERATIVE SOIL SURVEY

Soil Survey Conference Proceedings

Charleston, South Carolina
January 25-28, 1971

File Copy

J. Melvin Williams

S-3-415

Proceedings of -----

NATIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE
COOPERATIVE SOIL SURVEY

Charleston, South Carolina
January **25-28,** 1971

REPRODUCED BY

Soil Conservation Service
United States Department of Agriculture

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
Washington, D. C. 20250

April 27, 1971

SUBJECT: 1971 National Technical Work-Planning Conference of the Cooperative Soil Survey

TO: Recipients of Proceedings of the National Soil Survey Conference

Transmitted herewith are the Proceedings of the 1971 National Technical Work-Planning Conference of the Cooperative Soil survey. Information on some of the items in the committee reports on which agreement was reached was released immediately after cur conference through official channels for widespread use. Information on other item, on which there was agreement will be released soon. But other item; need further study. Thus, these committee reports should not be given widespread distribution. They have no official status in their present form. Many ideas, however, in these committee reports are being used in revising the Soil Survey Manual.

Five (5) copies of these proceedings are being sent to each RTSC and about five (5) copies are being sent to the office of each state conservationist for distribution to the appropriate state experiment station soil survey leaders and to soil survey representatives of other agencies that are engaged in soil survey work in the state. In addition, sufficient copies are being sent for use by the state soil scientist, assistant state soil scientist, and soil correlator. The state soil scientist may wish to circulate one copy of this report among the GS-11 and GS-9 soil scientists; but in doing so, it should be made clear that the information, ideas, and data in these committee reports simply represent trends in thinking and progress of work. Thus, they do not necessarily represent official views, although many of the methods ultimately may be adopted officially.

fifteen (15) copies are being sent to the Canada Department of Agriculture for distribution to key Canadian soil scientists.

R. D. Hockensmith
R. D. Hockensmith
Director, Soil Survey Operations

CONTENTS

CONFERENCE ARRANGEMENTS AND PURPOSE

Roy D. Hockensmith

The 1971 National Technical Work-Planning Conference of the Cooperative Soil Survey was arranged and conducted similar to the manner the 1969 conference was conducted which was somewhat differently than in former years. Instead of holding committee meetings during the conference, the committee work was done prior to the conference, mostly by correspondence. This shift in arrangements required prompt response to requests from the chairman of each committee to the members of his committee.

Each of the committee chairmen was allotted up to 2 hours (although some requested and used less than 2 hours, and some used more than 2 hours) for presentation and discussion of each committee report. Some of the committee chairmen distributed draft copies of committee reports 2 or 3 weeks in advance of the conference to the expected participants. This advance preview permitted the participants to become more knowledgeable of the subject, enter into the discussions more intelligently, and thus contribute more meaningful ideas. A copy of each committee draft report was in the hands of each participant during the presentation and discussion of each report. Some of the committee chairmen arranged with other members of their committees to conduct a panel discussion to bring out the highlights of the reports. Following the conference, each committee chairman reworked the draft of his committee report to incorporate the necessary modifications that resulted from the discussions during the conference.

We did, however, continue the past practice of having a 15-minute presentation on the first day by a representative from each of the four regions of the land-grant universities and by the federal agencies in the Cooperative Soil Survey. These included the Forest Service, Extension Service, Bureau of Reclamation, Bureau of Indian Affairs, and Bureau of Land Management. Also, presentations were made by the representatives from FAO, Rome; fmm Canada; and from the Weyerhauser Company.

The primary purpose of this conference was to aid in the continued development and improvement of standards for carrying on all phases of soil survey work. Of special importance are techniques for field mapping, soil descriptions, legends, soil classification, soil survey interpretations (both farm and nonfarm), and soil investigations; the development of adequate terminology with enough precision and standardization to permit maximum use of soil surveys; and methods of compiling soil maps and preparing manuscripts for the published soil surveys.

Emphasis was given to ways to improve soil surveys and their interpretations so they can effectively help individuals and groups to select soils for various purposes and to determine response of individual kinds of soil to management and manipulation. These continued improvements give assurance that soil surveys are designed to help all people using soils, or guiding others in their use, to tie the optimum selection among the alternatives for use and management in order to maximize investments of labor and money.

The national conference makes use of technical committee reports of the regional technical work-planning conferences of the Cooperative Soil Survey. The national committees study and express their views on proposals made by the regional committees. In this way the regional committees have clearer guidelines in moving forward with their committee assignments in future work. The national conference is held at 2-year intervals--in odd-numbered years. Four regional conferences (one in each land-grant university region) are also held once in 2 years but in even-numbered years.

Participants in the national conference include (1) scientific and technical leaders of the Soil Survey staff from the national headquarters office and members of the principal soil correlator' offices; (2) one state soil scientist from each of the four groups of states who attend on a rotation basis; (3) one to three land-grant university representatives from each of the four land-grant university regions; (4) one representative of each federal agency directly concerned with the National Cooperative Soil Survey; and (5) others from the Soil Survey staff, SCS technical branches of closely related work, and other representatives of state, federal, and other agencies when they have a definite place on the agenda.

Attendance at regional soil survey technical work-planning conferences of the Cooperative Soil Survey consists of one or more representatives from each of the land-grant universities;

one from each agency cooperating in the soil survey other than land-grant universities; SCS soil correlation staff in the respective RTSC; soil survey laboratories and soil survey investigations staff; state soil scientist, soil correlator, or both, and perhaps assistant state soil scientist in each state within each land-pant university region; one representative from other federal agencies cooperating in the soil survey; me or two from the national headquarters office in the Soil Survey; and others, such as range and woodland conservationists, resource conservationists, conservation engineers, and agronomists on invitation by the regional conference steering committee. The chairmanship of each regional conference alterrates between the land-grant university group and the SCS.

PARTICIPANTS AT 1971 NATIONAL SOIL SURVEY CONFERENCE
January 25-28, 1971
Sheraton-Fort Sumter Hotel
Charleston, S.C.

WASHINGTON OFFICE

Charles E. Kellogg
Kenneth T. Ackerson
F.J. Cat-lisle
M. G. Cline
J. A. Gockowski
R. D. Hockensmith
Wm. M. Johnson
Joe W. Kingsbury
A. A. Klingebiel
A. C. Orvedal
Roy W. Simonson
Guy D. Smith
Dwight W. Swanson
Dirk van der Voet

WASHINGTON-FIELD STAFF

L. J. Bartelli
J. Ellsworth Brown
J. Coover
Klaus W. Flach
L. E. Garland
R. B. Grossman
John E. McClelland
W. E. McKinzie
John D. Rourke
R. I. Turner
J. M. Williams
John E. Witty
Keith K. Young

SCS SOIL SCIENTISTS ON STATE STAFFS

Hubert J. Byrd
R. I. Dideriksen
C. M. Ellerbe
C. J. Koch
Victor G. Link
Robert F. Mitchel
Henry T. Otsuki
Sidney A.L. Pilgrim
Maurice Stout
R.D. Wells

OTHERS FROM SCS

Kenneth E. Grant, Administrator
Norman E. Shuler (Assistant State Conservationist, South Carolina)
Harold C. Enderlin (Engineering)
Paul E. Lemmon (Plant Sciences)
Wallace L. Anderson (Resource Development)

REPRESENTATIVES FROM LAND-GRANT UNIVERSITY REGIONS

North-Central - L. F'. Wilding (Ohio) and R. H. Rust (Minn.)
Southern - David E. Pettry (Va.)
Western - Rodney J. Arkley (Cal.) and A. R. Southard (Utah)
Northeastern - D. S. Fanning (Md.) and Gerald W. Olson (N.Y.)

REPRESENTATIVES FROM OTHER AGENCIES

Extension Service - Harold I. Owens
Forest Service - Olaf C. Olson and Adrian Pelzner
Bureau of Indian Affairs - J. D. Simpson
Bureau of Land Management - Ronald L. Kuhlman and Lyle Linnell
Bureau of Reclamation - Harold L. Parkinson

CANADA DEPARTMENT OF AGRICULTURE

Walter Ehrlich, J. S. Clayton, and Laurie Farstad.

OTHERS

R. Dudal, FAO, Rare.
Victor J. Kilmer, TVA, Muscle Shoals, Ala.
Thomas A. Terry, Weyerhaeuser Co., New Bern, N.C.
J. Sidi Limehouse, Charleston County, S.C.

NATIONAL COMMITTEES FOR
1'171 NATIONAL SOIL SURVEY CONFERENCE 1/

Committee 1 - Technical soil monographs, bench mark soil studies, and soil laboratory studies.

J. M. Williams, Chairman
James V. Drew
D. P. Franzmeier
Robert B. Grossman
A. A. Klingebiel
E. J. Pedersen

Committee 2 - Classes and phases of stoniness and rockiness.

S.A.L. Pilgrim, Chairman
James R. Cower
Clinton A. Mogen
W. E. McKinzie
Olaf C. Olson
Samuel Rieger
Bruce G. Watson

Committee 3 - Standards for descriptions of soils.

Frank J. Carlisle, Chairman
J. Ellsworth Brown
R. C. Carter
Arvad J. Cline
Marlin G. Cline
Raymond B. Daniels
J. A. DeMent
Raymond I. Dideriksen
Leland H. Gile
John W. Hawley
Geo. G.S. Holmgren
Ben L. Matzek
J. E. McClelland
Arnold O. Ness
Wiley D. Nettleton
Oliver W. Rice
Samuel Rieger
Roy W. Simonson
David F. Slusher
Mike Stout
Dwight W. Swanson

Committee 4 - Application of the soil classification system (includes former committee tonic on "Criteria for series and phases").

J. E. McClelland, Chairman
H. J. Byrd
M. G. Cline
J. R. Cower
J. V. Drew
L. D. Giese
C. H. Holzhey
J. D. Rourke
Roy W. Simonson
Guy D. Smith
R. I. Turner

Committee 5 - Engineering application and interpretation of soil surveys.

Keith K. Young, Chairman
H. C. Enderlin
L. E. Garland
L. N. Langan
Robert H. Jordan
W. C. Lynn
A. C. Orvedal
Adrian Pelzner
John T. Maletic
Harold Rib
R. D. Yeck

Committee 6 - Handling soil survey data (for more complete and accurate synthesis data on soils to improve classification and predictions by use of electronic equipment).

A. C. Orvedal, Chairman
R. J. Arkley
J. B. Fehrenbacher
K. W. Flach
D. P. Franzmeier
R. B. Grossman
John W. Hawley
P. E. Lemmon
Olaf C. Olson
G. W. Petersen
R. H. Rust
D. W. Swanson
L. P. Wilding

Committee 7 - Histosols.

W. E. McKinzie, Chairman
Morris Austin
J. E. Brown
R. L. Cunningham
J. Day
J. A. DeMent
R. S. Farnham
H. R. Finney
R. W. Johnson
L. W. Kick
Gerhard Lee
E. J. Pedersen
Samuel Rieger
David Slusher
W. C. Lynn

Committee 8 - Criteria for classification and nomenclature of miscellaneous land types and definition of "topsoil," used to resurface cuts and tills.

Guy D. Smith, Chairman
L. J. Bartelli
F. J. Carlisle
R. C. Carter
Richard Huff
C. J. Koch
R. L. Marshall
J. E. McClelland
J. D. Rourke
J. M. Williams

1/ Not all committee members attended the conference.

Committee 9 - Soil moisture and temperature in relation to soil classification and interpretations.

R. B. Grossman, Chairman
R. J. Arkley
J. S. Clayton
Raymond R. Daniels
John F. Douglass
J. V. Drew
T. B. Hutchings
Franklin Newhall
H. T. Otsuki
A. R. Southard
Mike Stout
Rudolph Ulrich
J. M. William
R. D. Yeck

Committee 10 - Soil family criteria.

J. E. Brown, Chairman
R. I. Dideriksen
R. W. Eikleberry
K. W. Flach
W. W. Fuchs
C. S. Holzhey
A. A. Klingebiel
John E. Witty

Committee 11 - Soil interpretations at the higher categories of the new soil classification system.

J. D. Rourke, Chairman
K. T. Ackerson
D. S. Faming
A. C. Orvedal
Guy D. Smith
Keith K. Young

Committee 12 - Soil survey procedures (priorities for field work and publications, special soil reports including progress and quality control, small-scale soil maps, quality control of field work. and recording and reporting soil survey users' opinions and criticism of soil surveys).

J. W. Kingsbury, Chairman
L. J. Bartelli
M. G. Cline
L. E. Derr
J. V. Drew
J. A. Gockowski
R. D. Hockensmith
V. G. Link
R. F. Mitchel
H. I. Owens
S.A.L. Pilgrim
Robert Shields
Maurice Stout
Dirk van der Voet
L. P. Wilding
Bruce Watson

Committee 13 - Soil surveys of forested lands (with emphasis on mapping and interpretations),

O. C. Olson, Chairman
J. E. Brown
H. J. Byrd
J. R. Cower
C. M. Ellerbe
P. E. Lemmon
S.A.L. Pilgrim
Dirk van der Voet

Committee 14 - Environmental soil science

L. J. Bartelli, Chairman
C. R. Berdanier
J. B. Fehrenbacher
Tom E. Fenton
K. W. Flach
R. B. Grossman
George S. Holmgren
Victor J. Kilmer
Gerald W. Olson
Oliver Rice
R. H. Rust
Guy D. Smith
L. P. Wilding

1971 NATIONAL SOIL SURVEY CONFERENCE

AGENDA

Charles E. Kellogg, Chairman

Monday, January 25

8:30 a.m.	Registration	Clarence M. Ellerbe, in Charge
9:00	Introductions, Announcements, etc.	Charles E. Kellogg
9:15	Welcome to South Carolina	Norman E. Shuler, Assistant State Conservationist, S. C.
9:25	Welcome to Charleston	J. Sidi Limehouse, Chairman Charleston County SWCD
9:35	Statement by Kenneth E. Grant, Administrator, Soil Conservation Service, USDA	
9:50	Remarks by R. Dudal, FAO, Rome	
10:00	Recess	
10:15	Accelerated Publication of Soil Surveys	William M. Johnson
10:30	Soil Survey in Canada	Walter A. Ehrlich
10:50	Soil Climate in Canada	J. S. Clayton
	Statements by Land-Grant University Representatives:	
11:20	Northeastern Region	D. S. Fanning
11:40	Southern Region	David E. Pettry
12:00	Lunch	
1:00 p.m.	North-Central Region	L. P. Wilding
	Western Region	R. J. Arkley
	Uses, Needs, and Priorities for Soil Surveys:	
1:40	Extension Service	Harold I. Owens
2:00	Bureau of land Management	Ronald L, Kuhlman
2:20	Bureau of Indian Affairs	J. D. Simpson
2:40	Forest Service	Olaf C. Olson
3:00	Recess	
3:15	The Weyerhaeuser Company Soil Survey Procedure	Thomas A. Terry
	Studies on Tropical Soils by the Bureau of Reclamation	Harold L. Parkinson
5:00	Distribution of all committee reports by committee chairmen.	
7:00	Committee meetings.	

Tuesday, January 26

8:00 a.m.	Committee 1 - Technical soil monographs, bench mark soil studies, and soil laboratory studies. J. M. Williams, Chairman.
8:30	Committee 2 - Classes and phases of stoniness and rockiness. S.A.L. Pilgrim, Chairman.
9:30	Committee 3 - Standards for descriptions of soils. Frank J. Carlisle, Chairman.
10:15	Recess
10:30	Committee 3 - Continued.
12:00	Lunch
1:00 p.m.	Committee 3 - Continued.
3:00	Recess
3:15	Committee 4 - Application of the soil classification system. J. E. McClelland, Chairman.
7-9 p.m.	Revision of Soil Survey Manual - Marlin G. Cline.

Wednesday, January 27

8:00 a.m.	Committee 5 - Engineering application and interpretation of soil surveys. Keith K. Young, Chairman.
9:00	Committee 6 - Handling soil survey data. A. C. Orvedal, Chairman.
10:00	Recess
10:15	Committee 6 - Continued.
11:30	Progress report on use of ADP in processing correlations and preparing tables for soil survey manuscripts. L. J. Bartelli.
12:00	Lunch
1:00 p.m.	Committee 7 - Histosols. W. E. McKinzie, Chairman.
2:00	Committee 8 - Criteria for classification and nomenclature of miscellaneous land types and definition of "topsoil" used to resurface cuts and fills. Guy D. Smith, Chairman.
3:00	Recess
3:15	Committee 9 - Soil moisture and temperature in relation to soil classification and interpretations. R. B. Grossman, Chairman.
5:00	Remote Sensing - A. C. Orvedal.
5:30	Cash Bar
6:30	Conference Dinner Meeting (Wives welcome). Presiding: L. J. Bartelli and J. E. McClelland.
8:00	Movie - "From a Distance."

Thursday, January 28

8:00 a.m.	Committee 10 - Soil family criteria. J. E. Brown, Chairman.
8:30	Committee 11 - Soil interpretations at the higher categories of the new soil classification system. J. D. Rourke, Chairman.
9:30	Committee 12 - Soil survey procedures. J. W. Kingsbury, Chairman.
10:00	Recess
10:15	Committee 13 - Soil surveys of forested lands. O. C. Olson, Chairman.
11:15	Committee 14 - Environmental soil science. L. J. Bartelli, Chairman.
12:00	Lunch
1:00 p.m.	Committee 14 - Continued. 1:00 Soil studies near Sardis, Turkey - G. W. Olson. 1:30 Use of fertilizers and water quality - V. J. Kilmer.
2:00	Closing remarks by Charles E. Kellogg.

SUMMARY OF REMARKS
by
Kenneth E. Grant *

I am pleased to take part in this conference of the National Cooperative Soil Survey. This cooperative program is carried on by the Sail Conservation Service and other federal agencies, land-grant universities, end other state and local agencies.

In addition to the regular soil survey activities that are being carried on with too few people end too little money, there are three additional large jabs that face us:

(1) he first and primary task is that of reducing the backlog of unpublished soil surveys and getting publication on a current basis.

(2) Second is the revision of the Soil Survey Manual. Much has been learned in the last 20 years about how to do this work, how to design soil surveys, ad how to interpret the results for use.

(3) Ccnpletion of the new Soil Taxonomy Manual is the third task.

Each one of these three tasks is a difficult job by itself.

These days, we hear a lot about ecology end the environment. We know that there are serious problems of air, water, and soil pollution. The Service, other federal agencies, and the lend-grant universities have been conscious of this end have been working on solutions for many years. We know that the kinds of soil we have been studying, mapping, and interpreting are ecosystems or potential ecosystems. Our philosophy of prudent soil use is based on en understanding of these ecosystems. But now we must find more end better ways to help guide thinking in this vastly complex area and help people to develop programs that will preserve end enhance the quality of environment, the natural resource base, end family standards of living,

Although our soil survey work began near the end of the last century to help farmers, we can no longer make the sharp distinction between farming end other land uses. What happens on the farm affects the environment of city people. Similarly, bad city planning hurts the farm people. Either can help or injure the environment. Knowledge of soils and especially knowledge of their potentials and limitations are needed by both. It is through joint planning by both that we can have the best results end put our soil surveys to their greatest use.

Now I would like to give you a few thoughts for your consideration. The desire for excellence, the desire for perfection, and continuous emphasis on professionalism are goals of all uf us. We need, therefore, to raise questions on some of our activities. The 1970's are not the 1960's. We are in a period of accelerated rate of change. I em referring to priority of areas for soil surveys. When there are one hundred people in one location end one million in another, it should be obvious that the area with the one million people must receive a higher priority for a soil survey.

If we have an area that has few problems and en area with severe problems, then the area with the severe problems must receive a higher priority for a soil survey. The priority for our surveys must go to those areas where the need is most critical.

Over the years, I have heard the comment that our soil survey party leaders are not good writers. Based on my experience in working closely with party leaders, I believe that they are competent, capable people. If they are not good writers, where does the problem lie? Perhaps it is our fault as much as theirs. I raise these questions--What are the universities doing to overcome this deficiency? What is the SCS doing to overcome this deficiency? Action must be taken early in a man's career to overcome shortcomings in this area.

Another comment that I hear is that the most urgent surveys are not scheduled for publication. Areas are being scheduled where there are fewer then 10,000 or possibly only 5,000 people living in the area. We must consider the critical areas when developing schedules for publications and give them high priority.

* Administrator, Soil Conservation Service, USDA, Washington, D.C.

We have written much over the years with respect to the cost-benefit ratio of soil surveys. We have made statements that their use will save millions of dollars for a county. Yet as we work with planning agencies and units of government, we find that even where a soil survey exists many decisions are being made without using it. We must have failed somehow to reach the right people with our information. This is a situation that we must change. People who should be using this information must be made aware that it is available.

If the soil survey is as valuable as we believe it is, and say that it is, why do we have thousands of copies of surveys in storage? Congressmen ask us for help in distributing their copies. The storage cost of soil surveys is critical. This problem of getting soil surveys cut into the hands of people who need them and can use them and out of costly storage is another area that needs attention.

Another comment that I hear is that the published soil survey in its present form is written for a relatively few soil scientists. It is not written in a language or prepared in a format that is used easily by the kinds of people who are using soil surveys today. If we want and expect people to use the published soil survey, it must be in a form that is easily understood and used.

I know that you are working hard at program improvement. I ask that you give consideration in your discussions this week to these subjects I have merely opened up to you.

Thank you.

SUMMARY OF STATEMENT
by
J. Sidi Limehouse

Mr. Limehouse, who is chairman of the Charleston County Soil and Water Conservation District, extended a cordial welcome to Charleston. He gave an interesting and informative account of the earlier history of the Charleston area and shifts in land use from marshes to rice production and later the movement of rice westward to the extent that no rice is now grown in this county. Much of the formerly famed areas is now covered with houses and other buildings. There is great pressure by people to preserve the marshes. Zoning may be required to do this.

SUMMARY OF REMARKS
by
R. Dudal*

Dr. Dudal expressed his appreciation for the invitation extended to FAO to participate in this conference. He predicted that the results of this conference would reach far beyond the boundaries of the United States. He emphasized that FAO in its work in developing countries is using soil survey techniques and methodology worked out in the United States. Two documents especially that have been instrumental in programming a great number of FAO field activities are the Soil Survey Manual and drafts of the Soil Taxonomy Manual.

Dr. Dudal outlined FAO's program in the field of soil survey including soil interpretations, fertilizer promotion, land reclamation, soil data processing, soil conservation, and soil testing. He did this in a way that showed the possible application that FAO could make of the committee reports presented at this conference.

later, he gave a progress report on the preparation of the World Soil Map.

---

*Chief, Soil Resources, Development and Conservation Service, Land and Water Development Division, Food and Agriculture Organization of the United Nations, Rome.

REVISION OF SOIL SURVEY MANUAL

Marlin G. Cline

Dr. Cline helped guide a considerable part of the discussions following presentations of committee reports so that they would be of major value in revising the Soil Survey Manual. His contributions are reflected in the reports of the committees.

SOIL SURVEY ACCELERATED PUBLICATION PLAN

William M. Johnson*

It is the policy of the Soil Conservation Service to publish in appropriate form each soil survey as soon after completion of field work as maps and manuscripts can be prepared. This policy rests on the federal policy on public printing and documents, U. S. C. 44, 1964 edition, Supp. V, paragraph 1342. This paragraph says in part, "As soon as the manuscript can be prepared with the necessary maps and illustrations to accompany it, a report on each soil area surveyed by the Secretary of Agriculture shall be printed...."

Publication Imbalance

Since 1951 the amount of money and the "umber of people allocated to soil mapping have increased gradually, but there has been no equivalent increase in inputs for publication of soil surveys. The result of this imbalance has been the gradual accumulation of a backlog of unpublished mapping. The backlog reached a total of about 400 soil surveys by July 1, 1970. Currently, field mapping is being completed at the rate of about 60 surveys per year.

Development of Accelerated Publication Plan

In September 1969 Administrator Grant called for efforts to design a plan for accelerated publication of soil surveys so as to reduce the backlog and achieve a balance between the rate of completion of field mapping and the rate of publication.

Several plans were presented by the Washington Soil Survey staff, with different inputs and different timetables. Mr. Grant selected the S-year plan that includes an Advance Happing System (AMS) as one component. This 5-year plan contains the publication goals that are currently guiding our efforts.

The 5-Year Accelerated Publication Plan

The S-year plan calls for: (1) Rapid acceleration in the publication rate, followed by a reduction to a" annual rate approximately equal to the rate of field mapping. (2) Assignment of map manuscript compilation to the states (instead of the Cartographic Division) for four or five years, until the Advance Mapping System is fully equipped and operational and the backlog has been published. (3) Improvement of quality of manuscripts submitted to Hyattsville, to be accomplished by systematic technical reviews and revisions in local and state offices and the RTSC's. (4) Editing of the majority of manuscripts by contract with commercial editing firms. (5) Substantial extra inputs of money during the acceleration period. (6) Modest increases in staff in the RTSC's and the soil survey manuscripts office in Hyattsville, and moderate increases in Cartographic staff until the cartographic backlog is overtaken, with subsequent reduction to current staff numbers or below.

Publication Goals

This table shows goals for publication of soil surveys in the 5-year plan.

Fiscal year 1971	60 soil surveys to GPO
" " 1972	120 " " " "
" " 1973	140 " " " "
" " 1974	130 " " " "
" " 1975	130 " " " "
" " 1976 and following years	80 " " " "

* Soil Survey, Soil Conservation Service, U. S. Department of Agriculture, Washington, D. C.

Extra Inputs

This table shows the estimated total cost for completion and publication of soil surveys in the S-year plan, including technical review and editing, cartographic work, printing and binding, and overhead.

Eiscal Year	Estimated Total Costs (Dollars)
1971	4,702,000
1972	5,833,000
1973	6,272,000
1974	5,751,000
1975	5,375,000
1976	3,548,000

The above include nearly $1,000,000 for AMS equipment and programs. The estimates are based on the following general cost estimates for preparation and publication of soil surveys:

Technical review and editing of text manuscripts	$9,000
Cartographic work (including map manuscript compilation in the states, in-house cartography, and outside contracts) -	26,000
Printing and binding	10,000
Total for an average area -	$45,000 per survey

Progress to Date

Progress has been encouraging so far. We have found a substantial capability for contract editing of text manuscripts in the Washington area and the costs of this editing have been below our earlier estimates. We have bee" able to purchase a coordinate digitizer and companion quantizer and a large Cal-Comp automatic plotter, both important components of the AK. As funds become available, we shall add more digitizers, a digital scanner, and a small computer, as well as a cathode ray tube display system for review and editing of compiled soil maps. We shall send at least 60 soil surveys to GPO during the current fiscal year. We have a good headstart on the editing of manuscripts for fiscal year 1972. Cartographic work for fiscal 1972 and fiscal 1973 publications is on schedule or ahead of schedule.

SOIL SURVEY ACTIVITIES IN CANADA

W. A. Ehrlich*

In Canada, increased emphasis on interpretations of soils information is gradually changing the pattern of activities followed in current soil survey programs. I" new surveys and resurveys under way, considerable time is spent by the parties in evaluating soil data. Some of the interpretations are carried out cooperatively with expertise in other disciplines, principally forestry and to a lesser extent in engineering, wildlife, and recreation.

Our interpretive efforts on soils information in the past were concerned mainly with agriculture. These were directed to sail ratings. productivity evaluations, soil problems, management, and a few others. I" 1963 a change occurred when it was requested that a,, the surveyed land be classified within five years for soil capability for agriculture. This crash program involved about half of our soils staff for that period. Currently the capability classification has exceeded the soil survey coverage of 327 million by 90 million acres. This program will be continued at least until another 500 million acres have bee" classified. This limit established by ARDA (now within the Department of Regional Economic Expansion) is about 300 million acres short of the permafrost zone. Because land under forest occurs up to the zone with continuous ice, it is expected that surveys and interpretations will be made, some day, up to the tundra region. Sometime in the future, the land in the far north may be gainfully used for purposes presently thought to be impossible.

To survey the very large area (800 million acres) of land under forest with limited accessibility presented a problem if the survey were to be economical and the information obtained to be useful. To overcome this problem, the Department of Fisheries and Forestry, who had greatest interest in these lands, selected a number of foresters with soils training to develop a classification system and procedures to follow in mapping. A scheme was developed called Biophysical Land Classification. This system was tested for its feasibility and usefulness through the mapping of four pilot areas at widely scattered points. The scheme was used by four different teams, each on a different pilot area. The projects on completion were cross-checked to assess rhe respective interpretations by the other teams. Each team consisted of a pedologist and foresters with some support from expertise in geomorphology, plant ecology, wildlife, and recreation. The surveys were principally controlled through serial photograph interpretations; ground control was limited to spot checking mainly through the use of helicopters. The experiment resulted in a number of modifications of the original scheme to a system with possibilities. A number of areas have been surveyed by foresters with some input by pedologists; but to the present time. the classification has not received full acceptance by the soil survey committee. Some of the committee members think the scheme is too loosely defined and arranged to obtain the degree of uniformity desired in interpretations from one area Lo another. Obviously the system can and likely will be improved. The scheme has the following classification units:

<u>Land Region</u> - an area of land characterized by a distinctive regional climate as expressed by vegetation.
<u>Land District</u> - a" area of land characterized by a distinctive pattern of relief, geology, geomorphology, snd associated regional vegetation.
<u>Land System</u> - a" area of land throughout which there is a recurring pattern of landforms, soils, and vegetation.
<u>Land Type</u> - an area of land on a particular type of parent material, having a fairly homogenous combination of soils and chromosequence of vegetation. This is considered a basic ecological unit.

Another feature in the interpretation field receiving attention is Land Capability Analysis. This analysis is intended to show the best physical capabilities and patterns of the land for various uses. These capabilities include agriculture, forestry. wildlife, and recreation. This analysis may be considered as the first seep for land "se planning.

A scheme for capability classification for organic soils was set up and tested last summer. Like all new classification systems, the scheme has weaknesses and needs adjustments. The principal criteria presently used are organic matter decomposition, water conditions, reaction, climate, woody conditions, surface roughness, and thickness of peat. Each criterion is evaluated as it applies to the soil, and all criteria are summated to a numerical value which establishes the soil class. Seven classes are defined.

*Canada Department of Agriculture, Ottawa, Canada.

At the national meeting held in October 1970 at Ottawa, ten subcommittee reports were presented.

On the "Classification of landforms" no agreement could be reached on the approach to be used; therefore, it was recommended that a request be made to the Geological Survey of Canada to either provide or assist our subcommittee in establishing a nationally accepted scheme.

The subcommittee on "Soil moisture regimes" in its quest for improvements in criteria for soil drainage classes in the soil classification system, found that much more data are required before firm recommendations are possible.

On "Soil climate" good progress was made. This report will be presented by Mr. Clayton.

The subcommittee on "Soil survey interpretations for engineering use" reported that sufficient interest has been generated by soils men and engineers in some provinces to establish cooperative efforts. The National Committee considered that the soils men should not make interpretations for engineering purposes without assistance from engineers.

The report on "Crop yield assessments" recommended a stronger effort by soil workers for gathering statistics on crop yields on different soils and at different management levels for publication in soil reports.

On "Soil correlation" the subcommittee reported the necessity for a much greater effort to work out the soil classification problems that exist. An increase in staff is planned.

In the report on "Storage and retrieval of soil survey data" the need for facilities was strongly emphasized. It is planned to provide a system in Ottawa under the Soil Research Institute that will service the soil units across Canada.

In the discussion on "Soil reports," three recommendations were made:

(1) Future soil reports have two main parts--one part which brings together general information on the soils and their interpretations of their capability for use, the other part describing the morphology and classification of the soils.

(2) The interpretations for use be written by, or in consultation with, persons qualified in the particular discipline.

(3) The "Style Manual for Biological Journals" be the standard followed in editing soil survey reports.

The report on "Soil families" emphasized the need of this category to assist in the sorting and grouping of series; also it was indicated that the sorting would point out the discrepancies in the criteria used for series, family or both.

In the taxonomic classification, some changes were proposed and accepted in the classification of organic soils; and some modifications were proposed for soils in the other orders. The changes in the organic order, seven in all, are modifications in definitions, arrangement, and naming--they do not affect the basic structure of the scheme. These revisions are to be placed in the new handbook. The changes proposed for the other orders were discussed but were tabled either for further consideration or to be incorporated in the handbook at the next printing. About 1100 copies of the handbook, released last September, have been distributed.

Active involvement of the soil survey organization appears inevitable, at least for a period of time, in the fields of remote sensing and in pollution. Since the announcement by NASA of the intended launching of the Earth Resources Technology Satellite (ERTS) in 1972, there has been considerable action in Canada to organize interested groups to combine their resources for a remote sensing program. It is uncertain at this time whether Canada will contribute to the cost of the ERTS venture or launch a satellite of its own. I" any case. some remote sensing programs are under way in which the soils men are raking part. One group worked in a farming area attempting to identify soil features for mapping purposes and the other in a forested region with local areas of permafrost. Films used were conventional black and white and color, infrared black and white and color, and multispectral bands. The areas were photographed at various elevations ranging from 6,000 to 27,000 feet (respective scales of 4 inches to 1.2 inches per mile). Interpretations have not been completed for the areas. It is indicated, however, that the techniques now available can greatly improve the scope and accuracy of interpretations from the photographs. It is believed also that there is a potential in the use of photographs from ERTS for a broad reconnaissance survey of the Canadian permafrost zone (about one billion acres) when the resolution is improved. The resolution of photographs taken at 500 miles is reported to be 300 to 500 feet. Other remote sensing experiments under way have been on cropped areas. At elevations of 6000 feet, the photographs (infrared color) showed distinct off-color areas later identified as a blight on a bean crop, yellow dwarf (celled takeoff) on barley, manganese toxicity in potatoes, and aphid infestation on corn. Investigations of those kinds will be continued.

In the field of pollution. the sails men are expected to undertake the responsibility of providing specific information and hard data on various aspects. One of these will be on location and management of erodible soils to reduce the amount of sediments carried to the streams. The problem of erosion resulting in pollution of our streams is probably more serious than most people realize. The seriousness of the problem could be multiplied many times because of the possible contamination of streams with the chlorinated hydrocarbon insecticides, phosphorus, and other substances attached LO the sediments. It is expected also that the sails men will have to give guidance to location of feedlots to avoid contamination of water with nitrates; to investigate the vicinities of mining areas for toxic substances such as arsenic, fluoride, zinc, or lead; and to work with pesticide expertise to evaluate the influence of soil composition on the degradability of pesticides. Other kinds of investigations likely will be requested, some of which will be through pressure from the public. It is hoped, however, that we will not he compelled to spend time and money on projects dreamed up by some soapbox orators.

In concluding this review of some of our activities, I wish to add that there is a gradual and continuous increase in demands for soil and interpretive information. In recent years, the interest has been more in the interpretations or end product of our investigations than in the basic data. Some users have no interest in the basic information; and if nothing else is available, they will da without. IL is a sign of the times--thinking my soon be obsolete.

Since this occasion my be the last time I will be attending your work-planning meetings, I wish to thank all of you, and your colleagues not here today, for the courtesies and assistance received from you over the years.

THE SOIL CLIMATES OF CANADA

J. S. Clayton*

Climate and weather involves temperature, energy, and moisture relationships of the biosphere in respect to place and time. Weather is a variable and immediate phenomenon involving these relationships. Climate is a longer term integration of these factors involving the probability of occurrence of conditions for a" area and for a stated time basis. In dealing with the climatic conditions of the biosphere we are particularly concerned with those portions involved with productive growth, ranging in entirety from a little above the upper height limit of plan growth to the depths in the earth beyond the extent of significant root penetration, and to the lowest depths to which daily and seasonal fluctuations remain significant. I" referring especially to soils we think practically in terms of a control section of about one metre to four feet, although some variability due to soil climate may be found at greater depth. These deeper effects are more significant to evaluation of soil for engineering interpretations, depth of freezing or permafrost, traffic stability, etc.

The concurrent developments of the FAD/UNESCO Map of North America, and the Soil Map of Canada, together with the increasing demand for correlation of capability interpretations relative to integrated resource management on a National basis, have focussed attention on the necessity of establishing a comprehensive soil climatic map and a framework for characterizing the varying climatic aspects of the soil regimes. This was recognized in 1968 at the 7th meeting of the Canada Soil Survey Committee when the first report of the Subcommittee on Soil Climate in relation to Soil Classification and Interpretation was presented. In this report it was suggested that geographic areas and soil groups should be defined with more precise climatic attributes. The committee pointed out that a body of climatic data for various regional areas was being accumulated and that sophisticated computational methods were becoming available for application.

Since that time we have been progressing towards these objectives. An initial submission of a Soil Climate Map of Canada and a framework for characterizing regional soil climates was presented to the Canada Soil Fertility Committee in February 1970.1/ The map, at a scale of 1:5,000,000 was developed so that it could be easily related to the map unit areas on the Soil Map of Canada. During the spring and summer of 1970, this was further submitted to the Soil Climate Subcommittee of the Canada Soil Survey Committee for consideration. It was also discussed with members of the provincial and regional soil survey groups across Canada. Suggestions from these local groups, particularly regarding the reasonableness and practicality of comparable classes and boundary separations within and across provincial regions were received, and after consideration many of these were incorporated in a revised map.

Currently, with these developments a copy of the initial report and map were given to Dr. Guy Smith for study. Subsequently we received a letter from Dr. Smith reporting Dr. Dudal from FAO as stating, "that we, the United States and Canada would be expected to suggest a map of the Climatic Regions of North America." Dr. Smith indicated that your group had studied the Canadian scheme but considered that while it appeared admirable for Canada, it would have serious limitations for the U.S.A. He suggested that the scheme could be modified to fit the continental patter" by adding additional classes and asked for suggestions.

After some study we replied by making suggestions for modification and expansion of the Canadian scheme to make it more comprehensive in terms of Heat Classes and Moisture Subclasses, and wide enough to be applicable, as far as could be visualized, to the North American Continent. We also suggested expanding the concept of Moisture Subclasses to include Aqueous and Aquic as well as Hoist and Dry regimes, and prepared charts to indicate such general relationships.2/

---

* Soil Research Institute, Central Experimental Farm, Canada Department of Agriculture, Ottawa, Ontario, Canada.

1/ J. S. Clayton. Characteristics of the agroclimatic environment of Canadian soils. Proceedings of the Canada Soil Fertility Committee, 1970.

2/ Report of the Subcommittee on Soil Climate in Relation to Soil Classification and Interpretation.
Proceedings of the Eighth Meeting of the Canada Soil Survey Committee, Ottawa, Ontario, 1970.

The current revised map and legend is based on these expanded concepts of class and subclass and make use of the terminology necessary. These were presented by the Climate Subcommittee to the plenary session of the Canada Soil Survey Committee in October. It was recommended that the Soil Climate Hap of Canada as presented be accepted for use on a provisional basis, subject to subsequent revisions within its broad framework, and with the expectation that it would constitute a segment of a" overall environmental map of the Soil-Air Eco-System. After considerable discussion this was approved by the plenary session. It is the essence of this map and report which I am presenting today. Preliminary copies of this report/ are available to your committee members.

I am not going into the detail of criteria used in this address except by reference to the subcommittee report. Rather I wish to present the Soil Climate Map and legend and discuss the general relationships involved.

The Soil Climate Map has bee" prepared at a scale of 1:5,000,000 on the Lambert Conformal Conic Projection which has been adopted for the majority of the resource maps of Canada including those for Glacial Geology, Physiography and Soils. A copy of the legend is included. In a general way it is self-explanatory. Four broad types of climates are recognized, i.e., Arctic, Continental, Maritime and Mountain Complexes. These are separated into ten classes of temperature relationships ranging from various degrees of Cold, Cool, Mild, Warm and Hot regimes. The last two, Very Warm and Hot are not considered as occurring in Canada. These classes are based on consideration of the length, degree and intensity of heat conditions during various seasons of the year.

These temperature classes may be further differentiated into 13 subclasses based on length and degree of expression of moisture regimes, ranging from Aqueous with free water surfaces, through Aquic (saturated), to Moist (unsaturated) and Dry regimes. The most severely limited of the unsaturated regimes (perarid) and the three expressions of Dry regimes, Aridic, Xeric, and Torric are not believed to occur to any significant degree in Canada. A broad spectrum of parameters for these classes and subclasses are suggested in Chart 1 and 2, Table 1, 2, 3, and 4 and Figure 1 (pages 2-9) of the Subcommittee Report.

It should be understood that the combinations of parameters and codings suggested are provisional and should not be regarded as rigid. They are open to modifications in the light of further knowledge, study and pragmatic reconsideration.

The selection of these classes and subclasses was chosen as far as possible to closely identify with or relate to, a number of loosely accepted groupsing and regional area separations which have been used at varying levels and degrees of abstraction and sophistication. These included the consideration of the report and map of Permafrost in Canada3/, the report on the "Climates of Canada for Agriculture4/ as prepared for the Canada Land Inventory, and the provisional reports of Temperature and Moisture regimes as suggested for the revision of the U.S. Soil Manual and the Comprehensive Soil Classification system. With regard to relationships of Vegetational Associations with climatic soil areas, the report and map of the Forest Regions of Canada5/ and the studies by Coupland6/ on the Grassland Classification in the Northern Great Plains have

2/ Report of the Subcommittee on Soil Climate in Relation to Soil Classification and Interpretation.
Proceedings of the Eighth Meeting of the Canada Soil Survey Committee. Ottawa. Ontario, 1970.

3/ Permafrost in Canada. Prepared by R. J. E. Brown. Hap and Explanatory Notes. Geological Survey of Canada. Hap 1246A. 1967.

4/ The Climates of Canada for Agriculture. L. J. Chapman and D. M. Brown. The Canada Land Inventory. Report No. 3. 1966. Department of Forestry and Rural Development.

5/ Forest Regions of Canada. J. S. Rowe. Forestry Branch. Bulletin 123. Department of Northern Affairs and National Resources.

6/ A Reconsideration of Grassland Classification in the Northern Great Plains of North America. R. T. Coupland. J. Ecol. 49. 1961.

also been considered. The major consideration however was to relate the classes and subclasses es closely es possible to the well established classical separation of zonal soils, particularly in the Northern Great Plains where the genetic relationships of soils, climate and vegetation have stood the test of time and practical interpretation. Thus, class 1A and 2A, Extremely Cold Arctic and Very Cold Subarctic are closely coincidental with the widely used concepts of permafrost and intermittent or discontinuous permafrost areas and with Cryic end Tundric soil and pergelic regimes. In vegetational association they relate to Barrens, Tundra and Tundra-Forest transitions. Class 2A when used within (complexes of) Mountain Climatic types is usually associated with Alpine soils and vegetation. The Continential types are characterized by wide diurnal and seasonal fluctuations. Class 3C and 4C, Cold and Very Cool Continental climates with very cool summer seasons in terms of accumulative degree days and summer season temperatures, fall generally into the concepts of Cryo-boreal climates. It was considered desirable for practical interpretations of soil capabilities (in Canada) to make two separations in this grouping. The class 3C Cold continental climates are of greatest occurrence in the Northern Great Plains and Northern-Interior Plateaus of British Columbia.

Classes 5C and 6C, Cool to Mild Continental climates have warmer summer seasons in terms of accumulative degree-days and seasonal temperatures than classes 3 and 4, end correspond generally to Boreal end Frigid regimes. Here again it was considered desirable to make two separations within this range.

Classes 7C end 7-8C transitions with moderately warm to warm continental climates correspond closely to the coolest types of the Mild climates with Mesic regimes, having annual temperatures greeter than $8^{o}C$, $47^{o}F$. These are associated with the warmer soil areas characteristic of Udolls end Ustolls. Here again two separations are considered significant in Canada but only very limited areas of Warm Continental, Class SC occur in Canada, mostly confined to the South West St. Lawrence Lowland, the Niagara Peninsula, end in portions of the Okanagan end Thompson valleys of the Cordilleran Interior Region.

Smaller areas of Maritime climatic types with modified diurnal end seasonal fluctuations in comparison to the extreme continental types are indicated as occurring in the Maritime Provinces, and on the Pacific Coast and Islands. Generally they have comparable annual and seasonal temperatures and accumulative degree days to the corresponding classes for the Continental types but the growing seasons are longer end the accumulative degree days per day are significantly less.

The Mountain types are show" es complexes of varying temperature class end moisture subclasses due to differentiation in vertical zonation and aspect. Most of these could be separated by more detailed mapping and study into their significant components. They include the greeter proportion of the Alpine soils and icefields associated with Cordilleran physiographic areas but range through the whole gamut of Classes and Subclasses.

The separation of Moisture subclasses, attempts to recognize the significance of the Aquic, Moist, (Udic and Ustic), and Dry, Aridic, Xeric end Torric Regimes. As stated previously, the latter "Dry" regimes are not considered to occur significantly in Canada. Of greatest significance In determining the regional or zonal climates of moderately to rapidly drained soils, are the moist and submoist subclasses with variable degrees of unsaturation end periods of moisture limitations. Six subclasses in this group ranging through Perhumid, Humid, Subhumid, Arid and Perarid were considered necessary to significantly separate such conditions. These were chosen to broadly relate to the well established zonal concepts of chernozemic soils associated with the arid to subhumid grassland end forest grassland transition, of the Western Prairies end Interior Mountain areas end with the subhumid, humid and perhumid concepts relating more closely to Luvisolic, Podzolic end Brunisolic soils developed on mesophytic forest and true prairie sites. The perarid subclass of greatest moisture limitations, associated with discontinuous sward cover end xerophytic vegetation are of minor occurrence in Canada except in local areas of the British Columbia interior. The suggested parameters for these classes are based on ranges of moisture deficits and precipitation indexes derived from precipitation and potential evapotranspiration, relating to storage capacities es indicated in Chart 2.

The addition of Aquic subclasses was introduced to enable further characterization of map unit areas where complexes or associations of well drained "zonal" soils with imperfectly to very poorly drained Gleysolic or Organic soils associates are know" to occur. They are indicated on the map solely by the occurrence of such units on the Soil Hap of Canada, and the subclass is based on a crude estimate of the duration period of saturation. It is recognized that the occurrence and classification of these subclasses depend on a number of independent factors including:

(1) The accumulation of surplus precipitation in an area, above the capacity of the soil to readily absorb.

(2) The ability of the soil to remove such surplus either by internal drainage or surface runoff.

(3) The characteristics Of the land form, topography and drainage pattern of the map unit, as for example, patterns with dendritic patterns of external drainage or with patterns of enclosed depressional contours lacking external outlets.

Because of such factors, and lack of mapping detail and precise observations, we are only able to generalize as to the map unit areas where significant inclusions of aquic regimes may be expected to occur.

It is hoped that current work by the Agrometeorology Branch on calculations of moisture surplus as well as moisture deficits, will enable us to evaluate these soil landscape areas more successfully in terms of the microclimatic level of abstraction.

This in essence is the background to the present Soil Climate Hap of Canada. Data for a soil climatic analysis of a number of selected meteorological stations representative of the various climatic classes and subclasses is given in Table 5. A series of Environmental temperature charts showing the patterns of degree and gradient of Air and Soil temperature relationships for selected stations are presented.

TABLE 1. CHARACTERIZATION OF THE SEASONS AND PERIODS

S_1: **Growing Season** - tile periods when the soil temperature (50 cm) is , 5°C (41°F)

P_1: Mild Growth Period
> 5°C (41°F) but < 15°C (59°F)

P_2: Thermal Growth Period
> 15°C (59°F)

S_2: **Dormancy Season** - The periods when the soil temperature (SO cm) is < 5°C (41°F)

P_3: Cool Dormant Period
'5% (41°F) but > 0°C (32°F)

P_4: Frozen Dormant Period
< 0°C (32°F)

The depth of the soil frozen during the "Frozen Dormant Period" my be expressed and coded as:

Code	Depth of Freeze
0	No freezing at 20 cm (S-inch)
1	Frozen at 20 cm (8-inch)
2	Frozen at 50 cm (20-inch)
3	Frozen at 100 cm (40-inch)

Each season or period may be characterized by parameters such as:

- Length of season or period in days
- Accumulated Degree-Days within the respective temperature levels
- Mean soil temperature for the months the temperature is within the respective defined levels or for December, January, end February as may be stipulated.

TABLE 2. DESCRIPTIVE TINE-SCALE TERMINOLOGY

Code Number	Description Term	Time Months	Period Days
0	None	0	0
1	Insignificant	< 0.5 months	< 15 days
2	Very short	0.5-Z months	15-60 days
3	Short	2-4 months	60-120 days
4	Moderately short	4-b months	120-180 days
5	Moderately long	b-8 months	180-240 days
6	Long	8-10 months	240-300 days
7	Very long	10-11.5 months	300-345 days
8	Nearly continuous	11.5-12 months	345-365 days
9	Continuous	12	365 days

TABLE 3. DESCRIPTIVE TEMPERATURE-SCALE TERMINOLOGY

Code	Temperature (°F)	Descriptive Terminology
1	< 20°F	Extremely cold
2	20°-< 32°	Very cold
3	> 32°- 36°	Cold
4	> 36°- 41°	Very cool
5	> 41°- 47°	Cool
6	> 47°- 59°	Mild
7	> 59°- 65°	Moderately warm
8	> 65°- 72"	Warm
9	> 72°- 85°	Very warm
10	> 85°	Hot

The Temperature Climatic Coding thus is based on a combination of the Code Number for a particular Tim and Temperature for a season or period.

e.g. 45 is moderately short, cool
62 is long, very cold
56 is moderately long, mild

TABLE 4. DESCRIPTIVE REQUIREMENTS FOR THE MOISTURE SUBCLASS OF THE MOIST REGIME

Symbol	Moisture	Irrigation Requirement	Precipitation Index
J	Perarid	> 12"	< 25
h	Arid	> 7.5" - 12"	25 - 45
g	Semiarid	5 - 7.5"	45 - 58
f	Subhumid	2.5 - 5.0"	58 - 73
e	Humic	1 - 2.5"	73 - 84
d	Perhumid	0 - 1"	84 +

Irrigation Requirement in Inches

Based on 50% risk. Storage capacity 2" and transpiration at .75 of potential rate.

Precipitation Index

Expressing as a % the contribution of seasonal precipitation to potential crop production.

REPORT OF THE LAND GRANT COLLEGE REPRESENTATIVE
OF THE NORTHEAST REGION

D. S. Fanning*

I am very pleased to be able to attend this conference and to be able to speak to people who are so influential of soil survey programs.

I accepted the nomination to become vice-chairman of the Northeast Soil Survey Work Planning Conference with mixed emotions, since I will be away for a year's sabbatic leave starting July 1, 1971, However, we have a good chairman in Sid Pilgrim and I probably will hardly be missed, I will be working on iron relationships in soil drainage sequences in Bavaria (West Germany) with Dr. Udo Schwertmann. While in Germany I shall be participating in the ISSS meeting this September on Psuedo-Gleys and Gleys--Genesis and Use of Hydromorphic Soils. So if anyone has anything that they would like me to try to find out or bring up at that meeting, I shall be glad to try to oblige.

Next, let me make a few remarks about the way our soil survey work planning conferences, both regional and national, are run. At our last Northeast meeting we followed the style set by the national conference in having the committees do most of their work before the conference, allowing more tim for all the participants to hear and discuss the committee reports. This worked very well. Most committee chairmen came to the conference armed with copies of their written reports and things proceeded very smoothly. In continuing this policy, three committees (1. Miscellaneous Land Types, 2. Climate in Relation to Soil Classification and Interpretation, and 3. Forest Soils) were set in motion this last summer to prepare for the 1972 Northeast Conference.

What I really want to suggest here, however, is that we consider making further changes in the way we conduct our business. In particular, I want to make a plea for greater regional autonomy. It has been my experience that most of the work for the regional meetings is done in response to the charges given to the regional committees by their respective national committees. This has the effect, I believe, of allowing too little time for the workers in the regions to consider their own individual or uniquely regional problems.

You might ask, what would the regional people do if the national groups didn't make such an effort to keep them busy. This is a fair question, and I suppose that we at the regional level might be in trouble if we had to do more thinking for ourselves. However, there are things that we could consider. For example, last year Dr. Dick Arnold at Cornell coordinated a regional survey of current research and research needs in soil classification, survey, and land use in the Northeast. He reported to the Northeast Experiment Stations Regional Research Committee that 5 items were considered most important. These were:

1. Need for studies of soils of tidal marshes.

2. Data collection of on-site soil factors as criteria for interpretations of soil survey for non-farm lard use. In this regard Dick has informed us that there was good consensus in the research committee: a) that we do not have the basic data to support many of our recommendations, b) that we need to define the areas in which studies are needed to provide high priority data, and c) that we need to develop field techniques that give reasonable estimates of pertinent parameters faster and possibly more relevant to field conditions than some precise laboratory techniques.

3. Assessing survey data for intensive land use.

4. Review of status of soil mineralogical data in relation to potential needs in interpretation, including classification.

5. Review of SCS research proposals by state representatives.

With regard to soil mineralogy I have been pleased to see that in the last year our regional soil mineralogy work group (which is separate from the soil survey work planning group) has finally gotten off the ground. The group met last week in New York and got to the point of really discussing the soil mineralogical research being done in the region. Our Northeast soil survey work group should interact with this group. The mineralogy group is hoping to

*Department of Agronomy, University of Maryland, College Park, Maryland

put out some publications on the mineralogy of the soils in the region and the soil survey people can help with this.

So I am saying that there is business that is more strictly regional in scope and that if the national conferences didn't keep the regional conferences so busy, more attention could be given to it. I suggest that more consideration should be Riven at the regional conferences to bending or shaping our national soil taxonomy system to better serve regional needs.

I want to finish up, however, by talking about our national soil classification system. I think most soil scientists in the experiment stations of the Northeast are quite happy with the comprehensive system and many of us use it in teaching soil classification and survey courses. We like the systematic nomenclature and, at least the idea of, exact definitions of classes. At Maryland, and throughout the region, SCS people have been very good in supplying us with maps and other materials to aid our teaching. Dr. R. W. Simonson has been especially helpful in speaking to my classes. Each year he gives his slide illustrated "Soils of the World" lecture and it is the highlight of my soil classification course.

For teaching, however, there is a need that I think has rat been fulfilled, and I don't know whose fault it is. We need some wall-size soil maps of the U. S. and of the world employing the new system. I am sure thw would be expensive because only a limited number could be sold. But for those of us teaching soil classification throughout the country they would be extremely useful, (and they should further publicize and advance the use of the classification system). The maps themselves are available but not wall-size versions of them.

Of the complaints that I have heard about the classification system in the Northeast, one of the main ones seems to be that it underemphasizes soil parent material. Part of this gets to be a semantical question, since one can argue that the parent materials of A and B horizons do not exist anymore. So I think what some of my colleagues are saying is that we need more emphasis, at least at the soil series level of classification, on the C and R horizons. Interpretations people say that one of the big values of soil surveys for nm-agricultural interpretations is that the soil series (at least as they have been defined in the past) have given a good indication in many areas of the kind of material that is beneath the soil. Thus they are warning us rot to become so engrossed in defining soils in terms of diagnostic horizons etc. that we forget some real important uses of the survey. They say let us be the rulers of the soil classification system and let's make sure that it works for us, not the other way around.

In closing, let me add that I haven't given much attention to the things that happened at our last Northeast conference. It was a good conference and those who are interested in the work of specific committees may, and probably already have, looked at the written proceedings of the conference. In this regard, I want to request that about 15 copies of the proceedings of the conferences in each of the other regions be made available to us in the Northeast. We need them particularly so that our committee chairmen can be well informed as tc what is taking place in their subject matter areas in the other legions. We need more of this direct communication between the regions.

REPORT OF THE LAND GRANT UNIVERSITY REPRESENTATIVE OF THE SOUTHERN REGION

D. E. Pettry*

The biennial Southern Regional Technical Soil Survey Work-Planning Conference met at Louisiana State University, Baton Rouge, Louisiana, on May 5-7, 1970, with S. A. Lytle, Louisiana State University, Chairman, and L. L. Lofton, SCS, Vice-Chairman. Some sixty-five members participated in the conference, representing the land grant colleges and experiment stations of most of the thirteen southern states and Puerto Rico, the Soil Conservation Service, the U. S. Forest Service, and the Tennessee Valley Authority.

Some thirteen committees with specific charges developed reports by correspondence prior to the conference. The following committees presented reports at the conference;

Committee I	Criteria for Family and Series
Committee II	Application of the New Classification System
committee III	Soil Interpretation at the Higher Categories of the New Classification System
Committee IV	Application and Interpretation of Soil Surveys
committee V	Handling Soil Survey Data
Committee VI	Soil Moisture and Temperature
committee VII	Miscellaneous Land Types and Soil Materials
Committee VIII	Realistic Estimates of Soil Survey Laboratory Work Loads
Committee IX	Soil Survey Procedures
Committee x	Soil Surveys for Forestry Uses
Committee XI	Regional Projects
committee XII	Southern Regional Map Project
Committee XIII	Regional Committee for Reviewing Changes in the Comprehensive Soil Classification System

Tropical Soils Workshop

Over 50 people participated in the Tropical Soils Workshop held in Puerto Rico and the Virgin Islands in August 1969. Some 43 participants came from the mainland and one from as far as Hawaii. The Workshop presented a unique opportunity to study soils, geomorphology and land use in a densely populated tropical area.

Considerable interest has been expressed to organize another workshop of the volcanic areas of Costa Rica. It has been suggested that emphasis be placed on the over-all environmental relationships for such a trip.

Southern Regional Hap Project

The Southern Regional Map of Great Soil Groups is nearing completion. Preparation of the map and legend are essentially complete, and the accompanying manuscripts are near completion.

* Department of Agronomy, Virginia Polytechnic Institute and State University.

Pollution

Recognizing the universal problem of pollution and the role and implications of soil surveys in this area, the Southern group moved that a committee on pollution be considered. Collection of data and application of research findings toward problems of pollutants related to taxonomic units was suggested as one of the possible roles of such a committee.

Graduate Programs in Soils

There was considerable discussion at the conference in Baton Rouge on the role of universities in providing educational programs of sufficient flexibility to fit current student needs. The Southern Work-Planning Conference heartily endorsed a resolution to encourage and support graduate programs in soil survey studies.

General Comments

There are a "umber of issues common to survey programs in the Southern Region, and perhaps they are relevant to other sections of the country. If one could describe the status of soil survey over the past decade in one word, that word might aptly be CHANGE. Change from a" old classification system to a new system. Change from the "old school of thought" to a "new breed". Drastic changes have occurred in our technical vocabulary which we use to describe and classify soils. Undesirable gaps often accompany changes.

Rather than a creditability gap, as some may prescribe, or a technological gap, we may be plagued with a communication gap. It is ironic that we communicate effectively from outer space, but encounter difficulty attempting to find out what is going on in the soil program in the next state or eve" the next county on occasions.

The lack of a" interstate correlator seems to severely hamper the continuity of mapping concepts across state lines. These same state lines often act as a termination point for series delineations. In some instances, the assignment of responsibility to one state for the revision of a" existing series which occurs dominantly in other states leads to confusion and friction. This confusion may be enhanced by the creation of a new series name to cover a previous error. Haste in making correlation decisions based on fragmental or too little data often leads to confrontations that are not easily resolved.

Much of the confusion could probably be resolved by improved communications; two-way communication. Procedures inaugurated a decade ago may not be adequate to meet current demands. Rapidly increasing uses of soil survey information for diversified purposes has opened new horizons. Accumulation of data, proper dissemination, and uniform interpretation seem essential for proper soil classification. It seems essential that we improve communication links among cooperating agencies if we are to properly meet the growing demands for quality soil information.

The next regular meeting of the Southern Regional Technical Soil Survey Work-Planning Conference will be held at Virginia Polytechnic Institute and State University, Blacksburg, Virginia, in 1972 with C. J. Koch, SCS, Chairman, and D. E. Pettry, Vice-Chairman.

REPORT OF NORTH-CENTRAL REGIONAL TECHNICAL COMMITTEE (NCR-3)
BY THE LAND-GRANT UNIVERSITY REPRESENTATIVE

L. P. Wilding*

This report will summarize activities of the NCR-3 Committee and some concerns of experiment station representatives in this region. Only a very brief resume of the North-Central Work-Planning Conference of the National Cooperative Soil Survey is included.

I. Activities of NCR-3

The regional committee has completed two projects end submitted a research proposal to the NC Board of Directors for consideration.

1. A folio of maps showing published soil surveys in the North-Central Region of the United States has been published in the September 1969 issue of Soil Survey Horizons 10(2):4-15. The state maps show the date of issue, availability, and distribution source of the most recent soil survey for each county in the region.

2. An updating of crop yields as presented in the NCR research publication no. 166, 1965, has been published in the February 1970 Crops and Soils Magazine under the title "Soil Yield Potential." A map illustrating the distribution of major kinds of soil suborders in the region is included (nomenclature is in terms of the present classification system with Great-Soil Group equivalents of the 1938 system given in parenthesis). Two thousand copies were printed for sale by Crops and Soils.

3. A proposed regional research project entitled, "Evaluating existing soil surveys and designing new soil surveys for various purposes" was transmitted to the NC Board of Directors. The proposal was considered too broad and encompassing by the directors and was returned to the NCR-3 Committee for further disposition. The Committee has not met since this action was taken. Several of the objectives of this proposal were as follows:

   (a) To determine composition of major mapping or landscape units on various land-forms and parent materials.

   (b) To evaluate current and potential mapping units for alternate agricultural and urban land uses.

   (c) To develop and test new techniques for detecting basic soil patterns significant for various purposes (remote sensing, statistical approaches such as factor analyses, etc.).

   (d) To evaluate the adequacy of the Comprehensive Soil Taxonomic System for differentiation of the significant landscape units.

II. Concerns of Land-Grant University Representatives

1. Are soil survey techniques, particularly field phases, advancing in tune with other technological advances in our society7

   (a) Inadequate use and availability of backhoe and power probe equipment for field explorations.

   (b) Need for additional solid research concerning type(s) of aerial photography that permit most efficient and accurate identification of soil patterns. Photography and timing may vary considerably from one soil region to another.

2. What about the professional image, esteem, and prestige of soil scientists? This is particularly important in recruitment of new men. What about SSSA certification of soil scientists versus certification of a soil scientist with broad field experience, but lacking some of the formal course training?

* Department of Agronomy, The Ohio State University, and the Ohio Agricultural Research and Development Center, Columbus, Ohio.

3. Most land-grant university representatives are spread too thin and must make priority decisions concerning their allocation of time to the soil survey effort. Interests and responsibilities in teaching, research, and extension are varied and numerous. This often results in problem of interagency communication and decision-making responsibilities.

4. Intra- and interstate interagency field trips on specialized problems are most beneficial and productive. Greater use of this vehicle to solve correlation conflicts should be encouraged (i.e. Miami field study in Ohio, Ind., and Mich.; Interfingering field study in Ohio; and Clermont field study with Ohio and Ind.).

5. Greater need for documentation of soil variability as related Co mapping unit composition, taxonomic class criteria, and sampling units. For example, should family textural boundaries be broadbrushed to encompass widths proportional to field sampling and laboratory errors? Same question for base status, organic matter content, COLE. clay mineralogy, and other definitive class criteria.

6. Need for rapid field method for determination of base saturation with soils in pH range of 4.5-5.5 to differentiate Alfisols, Ultisols, and Ultic intergrades.

7. We are seeing a redirection of efforts in most of the land-grant institutions towards more extensive environmental quality commitments. This will further broaden current responsibilities of experiment station representatives and tend to dilute present efforts to the Cooperative Soil Survey Program.

III. North-Central Work-Planning Conference of the Cooperative Soil Survey

This conference met March 2-5, 1970, in Champaign, Illinois. The conference worked through committees, the reports of which are in your possession. Aspects of several of the repot-ts follow.

Organic Soils

Procedures for handling organic soils are progressing. Despite these advances, there is a great need for analysis of organic soils within states for pH, mineral content, fiber content, temperature, etc. More descriptions needed. R. S. Farnham, Univ. Minn., has shown peat to be an effective sewage treatment and waste water filtering medium-strong adsorber of phosphates. Committee recommended reactivation of National Committee on Organic Soils.

Technical Soil Monographs and Benchmark Soils

No activity except work being done by North Dakota, South Dakota, and Minnesota in Red River Valley. Committee recommended that it be discontinued and become a subcommittee under laboratory information committee.

Soil Moisture and Climate in Relation to Soil Classification

Soil drainage classes not used uniformly across state lines. Present definitiona do not allow for placement of soil by moisture regime rather than by morphology when the two criteria disagree.

Coordination and Dissemination of Laboratory Information in the North-Central Region

Reviewed and discussed progress towards implementation of automatic data processing (ADP) in soil survey. Committee to be retained but with a change in name and objectives. The suggested name is "Committee for Communicating Soils Information for the Improvement of the Environment."

Forest Soils

Committee has been very active. It recommends exploring means for improving communications between soil scientists and foresters. A forest soils bibliography on forest soils research is in first draft stage but progressing. Research to provide better guidelines in evaluating land productivity for tree growth is in progress. Further study is needed to develop guidelines for multiple use management of forest lands.

Engineering Applications and Use of Soil Survey Data for Suburban Planning

Committee recommends more and better guides, better training for soil scientists, additional test data, and the name should be changed to be compatible with the National Committee.

Criteria for Series, Types, end Phases

Committee concerned about grouping of soils into families; particularly the development of large families with soils of contrasting characteristics. Distinctions between soil series, types, and phases need refinement end clarification. The use of taxadjuncts in correlations should be more restricted.

Soil Morphology and Soil Family Criteria

The committee agenda consisted of discussion of following topics: Study of genesis of Mollic Albaqualfs on contrasting landscapes in Illinois; phosphorus distribution as a criterion of soil development end moisture flow; mapping soils with infrared in Nebraska Sandhills; end correlation of soil morphology with *in situ* measurements of hydraulic conductivity. Also problems in classifying shallow-to-bedrock soils and using control sections were discussed.

Soil Correlation Principles. Procedures, and Rules

Criteria for wet soils need work end improvement. Soil moisture regimes are sorely needed. Correlation rules are designed to permit flexibility in correlation. Committee recommended that this committee be combined with Soil Series, Types, and Phases.

REPORT OF THE LAND GRANT COLLEGE REPRESENTATIVE
OF THE WESTERN STATES

R. J. Arkley *

The Western Regional Technical Work-Planning Conference biennial meeting was held in Las Cruces, New Mexico, on the campus of New Mexico State University, January 26-29, 1970.

In addition to the presentation of ten committee reports, the conference included:

1. A discussion of the soil survey program in New Mexico, by Victor G. Link, State Soil Scientist.
2. A discussion of soil correlation and interpretations by Keith Young, Assistant Principal Correlator, Interpretations, from Port worth.
3. A talk by J.M. Williams, Principal Soil Correlator, Portland. on recent developments in the soil survey program.
4. A report on recent developments end the status of the taxonomic soil classification system, by Dr. Guy Smith.
5. A talk by Henry Homan, Head, Cartographic Unit, Portland, on automated mapping by digitizing in the soil survey program.
6. A tour of part of the Desert Soil end Geomorphology Project conducted by Joah Hawley, project leader, assisted by Leland Gile, Soil Scientist. and a report on the project by Dr. Guy Smith.
7. A discussion of "The "se of Soil Surveys in Land Use Planning" dealing with planning and zoning problems in the vicinity of Albuquerque, by Stephen George, Executive Director, Middle Rio Grande Council of Governments.

These activities Preceded end were interspersed with the committee reports so that the conference was most interesting and productive. The committee reports have been published end placed in the hands of the appropriate committees of this conference, and I will not attempt to describe them.

A highlight of the reports was a presentation dealing with the use of 35 mm color and infrared color photography in soil surveys. The method is remarkably inexpensive and appears to be a most valuable tool for improving the accuracy of aerial photographic interpretation of soil patterns. Those of you who attended that SSSA meeting in Tucson. Arizona, no doubt saw a similar presentation by C. B. Gaudey, Soil Scientist, Soil Conservation Service. Auburn, California.

Another happy development was an invitation for the Conference to hold its next meeting at the University of Hawaii and participate in a field trip to observe and study the soils of the Islands.

As a representative of the Western Regional Soil Survey Work Group of the Land Grant Colleges, I would also like to report on some observations from members of the Work Group who were solicited by James U. Anderson, Chairman. The first has to do with the editorial handling of survey manuscripts, and I would like LO quote one paragraph from a party leader from an experiment station: "During the past year I spent 24 days searching out end correcting erroneous or misleading statements in the 'Edited' manuscript. Submission deadlines were met. When the galley proofs were checked. 18 additional days were needed to make the same corrections. This time, however, corrections had to be compromised end tailored to the existing space-count within the limits of line justification. Apparently, my corrections at the edited manuscript stage had been ignored." The author of this letter suggests that regional or local contract editing would permit author-editor consultation, save time, end avoid an inferior product.

Gerald Nielsen, Associate Professor of Soils, Montana State University, wrote: "I am generally pleased with working relationships between the SCS, Experiment Station, and Forest Service in Montana...My major complaint is the slow rate at which soil surveys are published, and the outdated interpretations that sometimes result. It also seems that demands for soil resource information in the state would justify an accelerated soil survey program. Finally, I believe that publication of the MY U.S. soil taxonomy system should be given the highest possible priority."

Dept. Of Soils & Plant Nutrition, University of California, Berkeley.

Warren Starr, Professor of Soils, Washington State University, wrote and listed the following for which more information is needed in published soil surveys:

1. Wilting point, field capacity, and available moisture capacity.
2. Temperature, soil temperature, and length of growing season.
3. Qualitative and quantitative data by soil horizons for salinity, where this problem occurs.
4. Definition of moisture flow and capacity or limitations of soils for engineering design of drainage and waste disposal.
5. Soil stability values for erosion, construction use, and hydrology.

For my own part, I have a suggestion for the conference. As we are all aware, areas of undisturbed sails end vegetation are becoming increasingly hard to find. I" California, Dr. Jenny end his wife have found that "here such areas exist on publicly owned land, it is not difficult to have small portions of these set aside as natural preserves to be left undisturbed for study and research, simply because it costs little to do this and does not involve land purchase. Once the area is located, it generally requires only that supporting letters be obtained from interested parties end submitted as a justification and that an individual pursue the subject with some vigor with the agency which has control of the lend. Generally, the agency simply does not know what areas are of scientific value for such purposes. With a little planning. the soil survey staff could find such areas and have them set aside for soil-vegetation preserves.

The last time I participated in the National Conference was in 1963, and it is a great pleasure for me to meet with you all again, and I am looking forward to a most interesting and educational meting.

USE OF SOIL SURVEYS 1/

I welcome the opportunity to participate in this National Conference dealing with the Cooperative Soil Survey, bath from my personal interest in soil surveys and their use and the Extension Service's involvement in the educational activities.

My approach to the topic of "Use of Soil Surveys," is to discuss educational programs and activities and relate these to the uses of the published soil survey.

I" order to reach a common understanding, let's look at the objectives of an education- al program. For this I will quote from the objectives written in a State program.

1. Establish the soil survey report as the most valuable inventory of soil resources in the area, both on the farm and ranch and in the community.
2. Furnish information and assistance in the interpretation and intelligent use of the report.
3. Establish the soil survey report as a valuable resource related to the county program in a broad sense such as acreage adjustments, conservation needs determi- nations, land use adjustments, tax assessments and equalizations, road planning, house development and others.
4. Provide information to the public on the availability, distribution and contents of the report.

Simply put a" overall objective of the Extension Service Educational efforts is, "The Effective Use of the Soil Survey Report." We share this with you and we don't want the soil survey reports gathering dust on people's shelves.

Extension's educational programs are carried out by the Cooperative Extension Service and the local leadership is assumed by the county or area Extension agents and specialists.

Methods and tools used to carry out a" educational program may vary to some degree from State to State, but you will note there are similarities in those used by many States.

I want to emphasize that the planning and carrying out of a" educational program is a joint responsibility. Extension can be effective in this, but full partners are the Soil Conservation Service, Agricultural Experiment Station and others.

I" the county it is important to involve the local Extension Agent or Specialist, the District Conservationist, the Soil and Water Conservation District Board of Supervisors, the Extension Council or Committee, other USDA Agencies, citizens groups and committees, units of government and others.

We are aware that the use of published soil survey reports has changed dramatically in recent years. These changes present us with opportunities as well as problems. It means there are many different users, not just agricultural interests. How do you tailor a" educational program that will reach each potential user? The engineer, the farmer, the county and regional planner, tax assessor, sanitaria", realtor, the developer, the forester, the Same manager, the homeowner, the city council, the zoning board, the county commission or board and the general public.

One principle we are told in education is - "To be effective is to identify your audience," plan your program to satisfy the needs Of the particular audience. Also, another princi- ple to make an impact is to use a rifle to hit the target or audience, if you please, not a shotgun.

1/ Prepared by Harold I. Ovens, Soil and Water Conservationist, Extension Service USDA, Washington, D. C. for presentation at the National Technical Work-Planning Conference of the Cooperative Soil Survey, Charleston, South Carolina, January 25, 1971.

As I review the plans for educational programs related to the identification of the "User Groups," the audiences, if you please, are usually spelled out. Each "User Croup" my require different sets of learning experiences. The common element in these experiences is to make the soil survey relevant to each user's needs.

The educational cessions, activities, demonstrations, tours and others are tailored to provide the best set "f learning experiences for the particular audience "I' "User Group."

Take for example, in Southeastern Wisconsin, in a seven-county area on educational project was developed and carried out over a four year period.

A little about the situation in the seven county area. It comprises the Southeastern Planning Region "f the State. It includes the city of Milwaukee. It is the most intensively developed area of the State. The population of the region is estimated at one and three quarters million. The area is rapidly becoming a single metropolitan complex of highly concentrated urban land users interspersed with a large area of mixed rural-urban.

Now back to the educational project - It made note of the wide variety of "User Groups" of soil surveys. Also, each "User Group" my require a different set of learning experiences. County agents identify soil survey "User Groups" and develop an educational program appropriate for each group. It also stated that for maximum impact with the "User Group," a major effort should start about the same time throughout the region.

They identified six high priority "User Groups" and developed educational program plans for each. The "User Croups" identified were:

1. General Public
2. Engineers and Surveyors
3. Public Officials
4. Assessors and Loaning Agencies
5. Farmers and other Rural land Owners
6. Land Developers, Realtors and Builders

Each county supplemented the regional plan with a county action plan. This educational effort was coordinated with the Southeastern Wisconsin Regional Planning Commission, the local planning commissions, agencies and boards, the Soil Conservation Service, the seven county Soil and Water Conservation Districts, and others to help achieve the full value of the soil surveys.

An example of a visual aid or a tool used in this program is found in the Waukesha County Soil Demonstration Form Project. The information from the detailed soil map ma used to plan alternative -uses of the land and the farm including agriculture, housing, industrial development, and recreation.

The soil map was used to develop a farm conservation plan. Two large plan maps show how homes can best be fitted to the farm land. One was based on the installation of private wells and septic tanks. The other was based on the installation of public sewerage and water lines.

The map identified wet subsoils where basements must be equipped with sump pumps. Other large plan maps show how the land could be used for an industrial park and as a recreation area. A zoning district map fits We soil and topography and intergrates land uses with those already existing around the farm.

As I mentioned earlier each of the seven counties developed educational program plans. According to their report as of November 10, 1970 more than 200 educational meetings had been held throughout the region to acquaint the appropriate audiences with the survey. What results were obtained with this hind of an effort? Here are some:

1. The regional planning commission has sold more than 10,000 soil survey map sheets.
2. Five of the seven counties have incorporated the soil survey into sanitary codes and zoning ordinances.
3. There has been substantial use of the survey in many types of land use decisions.

Here is the "Soils Development Guide," jointly prepared by the Wisconsin Regional Planning Commission and the Soil Conservation Service with financial assistance from the U.S. Department of Housing and Urban Development. The guide builds on the ideas presented at the 1967 conference on "Soil, Water, and Suburbia."

In central New York State a modest evaluation was made of the effectiveness of the educational programs on the application of soils information. A special educational effort was carried out by the Cooperative Extension Service, the Soil Conservation Service, planning groups at the county and regional level and others in the five county area around Syracuse, New York.

The special efforts included:

1. Distribution of Cornell Miscellaneous Bulletin No. 80, "Soils and Their Use in the Five County Area Around Syracuse," to 60 key offices for review and suggestions.
2. A soils interpretation workshop for the benefit of planners, natural resource agency people, and Extension CRD agents.
3. A summarization of the workshop, with a distribution of recommendations to We MIDNY Memo. Mailing list of 250.
4. Distribution as a MIDNY Nemo., a report prepared by the Soil Conservation Service on the extent and intensity "f soils mappings in central New York.
5. Small group discussions with planners, Soil Conservationists and Extension CRD Agents, on the use of soils information in the land use conflicts.
6. Announcement of the report on Soil and their use around Syracuse in MIDNY Memo., describing available publications.

Based on an analysis of the requests for soils information by nine categories they were ranked in the following order:

1. County planning boards.
2. Town planning boards.
3,4,5. Town board, regional planning boards, and health departments.
6. Building contractors.
7. Commercial site developers.
8,9. Industrial developers and others.

From this survey the conclusion was reached by the New York people as follows: "It would seem that soils interpretation educational programs, aimed at the several prime audiences identified, would continue to be a sound investment of time and program resources."

In South Carolina, I noted that besides agriculture uses special uses of soil survey reports which they identify include:

1. Land value
2. Engineering
3. Zoning and location

Kansas has recently published a bulletin entitled, "Soil Surveys are for Everyone." 'This pictorial bulletin presents a description of the uses of a soil survey. This is a companion bulletin to the Kansas bulletin,"How to Distribute and Use Soil Survey Results."

I hope you can get the point from these few examples of educational programs, activities, publications and methods which I have reported. I am enthusiastic about them.

Our Extension staff in Washington, D. C., has stepped up our efforts to support the educational programs. In our plan of work you will find that some 70 man-days are being devoted to improving methods of introducing Soil Surveys and increase the utilization of the data in farm and community planning.

During the past year in cooperation with Roy Hockensmith and staff of the SCS, Soil Survey Division, we initiated a notification to state Cooperative Extension Specialists some 90 days prior to the publication of a county or area soil survey report. This is a reminder to encourage them to finalize their educational plans for distribution of the report. In general, we have received a very favorable reaction to this cooperative notification arrangement. At the some time the Washington office of the SCS notifies the State Conservationists of the publication status.

We are very appreciative of this close working relationship. I have tried to discuss with you the Extension Service educational program in connection with the distribution and use of the soil survey reports and how this effort relates to the effective "se of the soil surveys by the many various "User Groups" and individuals. It is a cooperative job with the Extension input fulfilling an educational role and utilizing the technical expertise of the SCS, the Experiment Stations, and others.

It has been my pleasure to participate in this conference. I am expecting much good to come from our deliberations and recommendations.

STATEMENT PRESENTED TO
NATIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

Ronald L. Kuhlman*

We appreciate the opportunity to attend this work-planning conference. The Bureau of Land Management is continuing to strive for effective Soils information to assist in the formulation of management decisions affecting the 450 million acres of public land under our administration.

I. Recent Accomplishments

Since our last report in January 1969, we have made substantial progress in establishing a position for soils consideration in the Bureau. This includes:

1. The placement of Soil Scientists in four of our State Offices and six of our District Offices. We now have 12 Soil Scientists, compared with 9 in January 1969.

2. We have completed mapping on 530,000 acres in Western Oregon; 78,000 acres in Idaho; and 90,000 acres in Nevada. We have contractual agreements with SCS for 85,000 acres in Wyoming and 1,165,000 acres in Montana. These total 1,948,000 acres.

3. Instruction Memorandums have been issued to District Offices instructing them in procedures for preparing contractual agreements with the Bureau of Reclamation, Soil Conservation Service, or universities for soils data. It is anticipated that approximately 41,000,000 acres of additional soil inventories till be completed by the end of FY 1976. This increase in soils activity has been brought about primarily through the emphasis being placed on obtaining adequate soils date for use in development of Watershed Project Plans.. There is a significant need in these plans to relate vegetation and soils into logical planning elements for multiple use management. Long-term goals indicate a need for similar work on 160,000,000 acres by 2000.

II. Cooperative studies

We are continuing to fund research which will assist in the development of extensive soil inventory procedures through cooperative research studies.

These studies by State include:

Alaska - University of Alaska is collecting and evaluating basic resource data to develop criteria for the management of permafrost soils.

Colorado - USGS is continuing to study the Badger Wash Watershed Including its soil and vegetation relationships.

Idaho - ARS is under contract to intensively study the hydrology of small watersheds Including the soils within the Reynolds Creek Watershed.

Montana - ARS is continuing to study the hydrology of frail lands through land treatment practices and grazing systems on small watersheds having various soil conditions.

Nevada - University of Nevada has been studying soils in the Eastgate Basin as they relate to land treatment practices and runoff potentials.

New Mexico - San Luis Watershed Studies are Involved in the hydrology of small watersheds including their soils effect on runoff and vegetation.

---

* Bureau of Land Management, United States Department of the Interior, Washington, D. C.

Oregon - Oregon State University has completed a study on Resource Analysis Methodology which includes the use of multi-band spectral analysis and its application to resource management. This also involved a study of the relationship between soils and native vegetation.

OSU has also completed a literature review of serpentine derived sails.

Utah - Utah State University is studying soils associated with Pinon-Juniper cover on small watersheds and the effects of conversion of the P-J to range on runoff and erosion.

Sager Wash Studies by Utah State also include a study of the soils involved in frail lands.

Wyoming - Stratton sagebrush hydrology studies include work on the soil relationship to runoff and erosion under various management practices.

In addition, the Bureau is also actively participating in the W-89 and W-67 interagency committee.

The last cooperative study we wish to mention is our work with USGS in IR imagery and remote sensing techniques in the EROS program.

III. Cooperative Soil surveys Completed

Progress made on intensive surveys is limited primarily to a few instances where work was completed on a cooperative basis through the Soil Conservation Service or with the other organizations. Examples are the SCS survey near Lewistown, Montana; Eugene, Oregon; Duckwater, Nevada; and Bureau of Reclamation studies in the Snake River Basin in Idaho.

IV. Training

We have sent two of our Soil Scientists to the Bureau of Reclamation "Soil Scientist Training Institute" at Colorado State University. We hope to participate in other training sessions sponsored by the SCS, Forest Service, or the universities as we feel these are necessary to retain their technical capability.

V. Problems

The completion of our Soils Interpretation Manual for use by District Soil Scientists in the next few months will complete the manual instructions to be issued by the Bureau. From that point, we anticipate problems in obtaining soil interpretations for preparation and use by the Bureau. This will be minor, however, compared to obtaining personnel.

The completion of a soils inventory on 41,000,000 acres by FY 1977 is of primary concern. This will no doubt affect Soil Scientists and cartographic units in the Bureau of Reclamation, Forest Service, Soil Conservation Service, the universities, and Bureau of Land Management and private industry. We, in BLN, anticipate increasing our personnel to handle a substantial part of this workload, but do not foresee the possibility of completing the job with our own people.

I thank you.

DISCUSSION - USES OF SOIL SURVEYS IN THE BUREAU OF INDIAN AFFAIRS

James D. Simpson*

I appreciate this opportunity to again attend the National Technical Work-Planning Conference of the Cooperative Soil Survey. It is always good to be brought up to date on the progress being made by the Survey. I" addition, it is a real pleasure to see a lot of old friends again.

I would like to talk with you today about some of the progress that we in the Bureau of Indian Affairs are making. We are experiencing a great change in the role of India" people as they relate to the management of their resources. They are taking a much more active role in the decision processes relating to their own resources. This factor associated with "no change" budgets has necessitated an adjustment in the direction of our total program of which our soil and range inventory work is a" integral part.

The program has changed from one of technical assistance balanced with a small amount of development funds to one of almost pure technical assistance designed to give maximum help to the Indian people in their efforts to bring into harmony the physical, social, and economic factors involved in the use and management of their agricultural resources. This adjustment in our program has added greater responsibility to the role of the soil scientist. Since many of the decisions related to the use and management of lands are based on a" understanding of the soil itself, the decision maker needs to understand the basic physical conditions of soil, slope, and erosion--therefore, the soil scientist's job is self-evident. He must bring about on the part of those making decisions about use and management of agricultural lands:

1. Understanding of major significant differences in soil, slope, and erosion conditions that relate to their use and management.

2. Understanding of the basic effects of the significant differences in soil, slope, and erosion conditions in use and management.

3. Understanding of the principles to be followed in maintaining, improving, or compensating for differences in soil, slope, and erosion conditions when used and managed in harmony with the environment.

4. Understanding of the application of needed measures and the economic and social effects involved in applying appropriate principles in the use and management program.

This is a difficult job but one that the soil scientist, because of his basic training, has a" opportunity to furnish leadership. It is a very fundamental educational job relating to agricultural resource use. In the Bureau we are making a special effort to develop informational training programs that are designed to bring about these four areas of understanding. To date, we have worked in two of our administrative areas and response has been encouraging.

Since our last meeting here in 1969, our soil inventory program has become more involved in the effort the Bureau of Indian Affairs is making to establish Indians' water rights throughout the western part of the United States. This has entailed the development of information and materials relating to soil inventory work for use in pending law suits. There has been considerable expansion of field inventory work relating to acres of land suitable for irrigation. In this effort we are using all available soils information whether of a detailed or reconnaissance nature and making inventories for areas where data are not available. At this point our major effort is to develop a" estimate of the acres of Indian land suitable for irrigation. These data are being classified primarily by the land capability classification system and other guidelines established by the National Water Resources Council. I expect that the next two years will see a major effort on the part of the Bureau directed toward water rights litigation and intensive use of soils information for this purpose.

---

* Bureau of Indian Affairs, United States Department of Interior, Washington. D. C.

During the last two years the mapping phase of our soil and range inventory program Slowed greatly. In fiscal year 1970, we inventoried less than three million acres. The major reason for the reduction is that we are nearing completion of the inventorying of all Indian range and crop lands. This work is nearly 90% complete, but we still have approximately 10 million acres of woodland to be inventoried.

I" the area of woodland inventories we have been reluctant to extend our inventory program because of our lack of knowledge concerning highly significant mapping units within the commercial timber areas. Because of this, during the past five years, we have devoted most of our efforts relating to timber areas to a study of soil conditions found associated with continuous forest inventory plots, located on India" forests. As a result of this work and contracted assistance from the Michigan Institute of Technology, we now have developed a data processing program which we believe will allow us to correlate soils and timber growth using CFI data. From these studies we hope to develop significant mapping units for different kinds of forest growth. We also believe that the data processing program will have application to better evaluation of range sites. This system of data analysis is based primarily on establishing individual sites based on their quality as a growth media and stability against deterioration. Then using data from sites that had equal vegetative competition throughout the measured growing period involving such factors as tree species, basal area, and age of plants, comparative evaluations are made. Results show highly significant correlations of production and other differences by site for many different species of trees. To date, we have only processed data from one reservation, but have several others ready to be processed as soon as funds are available.

During the last two years we have also been exploring the use of automatic data processing as a tool for manipulating soil and range inventory data for farm and ranch planning. The biggest problem to date has been establishing a system of indexing that will allow the recall and data change of the smallest reportable unit found on the ground as related to ownership. In cooperation with the EROS Program the Bureau is in the process of soliciting the expertise of industry to furnish an operational demonstration of a resource information system utilizing present available data and related remote sensing data. We are hopeful that this study will produce the needed indexing system.

In conclusion I would like to give you a short review of our report writing program. These reports are designed to help bring about the first three areas of understanding I discussed a few minutes ago and to make a record of the inventory. Our progress is not as good here as it has been in completing the field work. This seems to be a common problem with all of us but we now have completed reports on more than 60% of the areas that have been inventoried and these are on hand at the reservations for use.

Thank you again for this opportunity to participate in this conference.

National Technical Work-Planning Conference
of the
Cooperative Soil Survey

Charleston, South Carolina
January 25-28, 1971

OLAF C. OLSON
FOREST SERVICE, "SM

I appreciate this opportunity to discuss with you the use of soil resource information in the National Forest programs. I am going to "se my allotted time to (1) review what we have learned during the past 10 years in the application of soil resource information to action plans in the Forest Service, and (2) to relate how this knowledge end increased understanding has caused us to modify certain aspects of our tote.1 soil science effort.

To begin. a" explanation about the general nature of the National Forest System action planning procedures may be helpful. Planning efforts can be identified at three major levels. The first or highest level in that which is associated with long term planning--the genera, allocation of resources and land uses to broad areas of land or to defined zones. This is the beginning of our multiple-use planning. The second major planning level is the development of short term resource and development plans. This is the planning that looks ahead 5 to 10 years. It has become clear that because this is the beginning of action planning, environmental protection in Forest Service land management operations really begins with this step. Failures in the application of basic resource data to the planning efforts at this level, either in regard to kinds of information or to their coordination, can be costly indeed. Ill-conceived projects such as those that are not generally in harmony with a" area's environmental capabilities and limitations will have tough going eve" with exceptional efforts at the individual project design level, which is the third end last major planning level to be mentioned here. The individual project plans, of course, require the most detailed soils information end the information must be precise and accurately located for the sites or areas involved. The soil information needs for short term planning should be more generalized--in fact, great detail is not desirable. Both planning efforts are equally demanding, however. as far as timing is concerned. The soil inputs to the long term planning efforts are the least specific but because broad resource allocations are based on generalizations or "average conditions." accurate generalized appraisals consistently produce better decisions.

The National Forest System contains some 187 million acres of land. We have bee" conducting detailed soil surveys under the guidelines of and in cooperation with the National Cooperative Soil Survey for the past 12 years in our Western Regions and for a somewhat shorter period in the Eastern, Southern, and Alaska Regions. Our accomplishments in these surveys have bee" approximately 20 million acres. In-Service reports have bee" prepared for all survey areas, and additionally, a few reports have been published in the standard USDA series. Our national average annual survey accomplishment is about 2 million acres. At this level of progress, we cannot hope to obtain coverage of the bulk of the National Forest System lands in anything approaching a reasonable period of time.

I" looking back for a moment, most of our Forest Service regional people several years ago perceived that some combination of reconnaissance surveys end detailed small-area surveys would be necessary if the urgently needed soil information was to be obtained at a meaningful pace. Accordingly, several Regions turned to reconnaissance surveys and designed them individually to collect the soil end related terrain data at levels of intensity that were commensurate with the time allowed for the investigations end with the intensity of detail that was appropriate for the foreseeable planning efforts.

The evolution of these strongly management-oriented sail resource surveys, or inventories as we prefer to call them, has bee" slow but the response to them has bee" very satisfying. We are presently seeing soil information getting into short term plans. We are seeing projects being designed in full consideration of the soil factors. We are seeing the land managers making plans and providing funds to obtain more soil resource information. However. because information for immediate problems stands high in the eyes of Forest Supervisors. many if not most of these managers want to buy soil management services (detailed information) in preference to the broader inventory information. This illustrates clearly that we have an important job to Set the horse in front of the cart on more areas.

There is no question but that our surveys and inventories are being shaped and molded to better fit the timing needs and the intensity levels most suitable for multiple-use action planning on the National Forest lands. We are also vitally concerned about building a quality inventory product. The recognition and delineation of the mapping ""its are based on natural land patterns at photo scales approximating 1 to 2 inches to the mile. These "patterns" not only include the patterns of the soils but also the associated patterns and characteristics of topography, geology, geomorphology, and vegetation, particularly as these related elements affect or influence the use and management of the soils. Detailed soil descriptions plus the measurements and observations needed for guiding the interpretive groupings and ratings. are made at selected locations. Compared to detailed surveys. our reconnaissance inventories have fever soil examinations per unit area but the individual examinations are equally intensive. Soil series classifications are used where the series have bee" well established and are recognized. Otherwise, the classification units that are established for a survey area are identified simply by the map symbols but may also carry some descriptive phrase or terms for narrative purposes. I" practice, the taxonomic units established tend to have somewhat broader ranges of characteristics than the taxonomic units of the more detailed surveys. Special attention is given to evaluating topographic characteristics and the C and R horizons. To facilitate regional comparisons, representative soil pedons are placed within the comprehensive soil classification system. I" the face of limited manpower, we have not bee" too concerned over the fact that these reports are not formally published. but we recognize that additional advantages would be gained by this step.

So much for the extensive surveys. As for detailed information, we are getting some of it through our cooperative detailed surveys and the rest of it through our soil management activities which provide such information on a case-by-case basis as arranged for. We find it necessary to custom fit, so to speak, any and all derailed information to the specific needs of the project. We have learned the hard way that even though good information may be available in a comprehensive report, this in itself is no assurance that the pertinent information gets into management plans. One of the most effective ways of getting soil information into action plans is through direct participation in the planning effort. This is one of the reasons why soil scientists are being placed on Forest Service interdisciplinary planning teams. The same is true for the other disciplines in the teams. A team approach provides the interdisciplinary "push and pull" that serves to make sounder plans than are likely to be made without such coordination and communication.

We have in our total soil science efforts still another area of responsibility, and that is providing soils training to those Forest officers who are responsible for executing the action plans. These people in order to do their Job correctly must have sufficient training in soil and water management to recognize problem situations before the problem actually occurs. It's a matter of training them to know when to call for help.

Among our many goals in looking ahead. we are aiming to provide information to all National Forest planning efforts on a timely basis. We want to see a more meaningful balance between detailed and reconnaissance survey activities. We look forward to continuing our cooperative soil survey efforts and especially on those areas in which other public and private agencies and parties are mutually interested such as RC&D areas. We are interested in developing cooperation in our soil resource inventories, especially in the area of classification--classification of the representative pedons--and perhaps in publication. We have a great need to develop better mapping procedures and methods end recent advances in remote sensing give considerable promise along these lines. We are shaping our soils program to include more coordination with the geologists. materials engineers, and hydrologists. We need to develop new procedures or adapt existing ones for measuring physical, chemical, and biological soil changes and to set our environmental soil quality standards. Because more end more management alternatives are being considered in land and resource management, the need for providing quantitative ratings. especially at the detailed information levels is continually becoming greater.

To summarize this look ahead, we see many advances coming in the use of soil information. Many of these will result because of the favorable trend toward the interdisciplinary approaches to problem solving and to coordinated resource management. For these reasons, we are aware that our efforts to provide usable soil information will have to be flexible and responsive. In "o other way will we be able to keep our newly won position in the front ranks.

REMOTE SENSING AND THE SOIL SURVEY

Arnold C. Orvedal*

Remote sensing has become a popular, general term applied to the full range of activities directly related to sensing from a distance. It, of course, includes ordinary panchromatic photography, which for many years has been the remote sensing technique used most.

Another term that has appeared is Earth Resources Survey (ERS) to mean the application Of remote sensing to getting data for resources on the planet earth. This term apparently evolved along with speculation about what can be sensed by earth-orbiting satellites, and we now have still another term--Earth Resources Technology Satellites (ERTS).

In December 1969, a USDA Earth Resources Survey Committee was appointed. Eleven USDA agencies, including the SCS, are represented on this committee. At the same time an SCS committee was appointed to deal with SCS interests in remote sensing (Orvedal, Gockowski, Enderlin, Blakely, and Ogrosky, who served until he retired last July 1969 and recently was replaced by Haas).

Last July and September the SCS (Orvedal and Gockowski) participated in a government-wide policy study Of the entire field of remote sensing, from aircraft as well as from satellites, related to earth resource surveys. This study was *de at the request of the Office of Management and Budget. The National Aeronautics and Space Council (of the White House) provided the chairmen and NASA played a prominent role; but, potential users, including the USDA, participated importantly too. Both promoters and authorities recognize and appreciate that people in agriculture, including soil scientists, are among the highly important potential users of advanced remote sensing developments.

At the present time there is a wide gap between what the optimists say can be done and what the realists (skeptics) say is reasonable to expect. Certainly a great deal of research and development, and testing, are necessary before we will know what is practical to gain from remote sensing and what is not. Yet, the prospects are good enough, even for soil surveys, to justify investigation of possible applications. Accordingly, some effort is being planned, which I shall discuss, but first a brief word about some of the technology of remote sensing.

Remote Sensing Technology

For more than 35 years conventional panchromatic aerial photography has bee" and continues to be the most widely used remote sensing technique. While this has served us well, the sensitivity of panchromatic photography, which is approximately that of the visible portion (0.38-0.78 microns) of the electro-magnetic spectrum, is narrow Rather recent developments have expended greatly the range of the spectrum that can be sensed from a distance. Nonphotographic techniques have bee" developed along with improving the versatility and range of photographic techniques. ADP procedures and electronic equipment are evolving to make rapid handling of volumes of data possible. me emphasis is on systems--the matching of a sensor, or more commonly a family of sensors, with data processing equipment, communication facilities, and whatever else is needed to round out a system.

With improvements in color photography along with the reduction in relative costs, color photography my become a competitor to panchromatic photography for use in soil surveys. Perhaps more important is the prospect of using more than one set of photographs. Such 8 set might be made up of two or more kinds of photography made simultaneously--multiband photography--or sets of one kind of photography made at different times of the year, or some combination of these. Examination of several sets of photographs of the same area is likely to yield more clues about soils than Just one; whether the additional clues are enough to justify the extra costs probably will depend on the general nature of the survey area.

Highly important in remote sensing is the development of nonphotographic sensors. With these, the spectrum that can be sensed remotely is extended on both sides of the photographic spectra, range. Eve" infrared photography can sense only a small part of the infrared range, 0.78-1.0 microns versus 0.78-1,000.0 microns. Nonphotographic sensors can operate in portions of the electromagnetic spectrum from ultraviolet (wavelengths less than 0.38) the entire infrared region and also through the microwave region, the upper wavelength limit of which is 100 cm. Radar is within the microwave range. Table 1 gives the wavelength and frequency ranges of operation for remote sensing.

*Assistant Director, Soil Survey Interpretations

An important fact about nonphotographic sensors is that photograph-like images can be made from the electromagnetic emissions or reflections that they do sense. Hence, outputs from them can be viewed and treated like photographs. For use directly with computers, nonphotographic sensors have an important advantage over photography, as impulses, after conversion from analog to digital form, can go directly into ADP systems for storage or analysis.

Along with improvements and new developments in remote sensing have come substantial increases in altitudes from which sensing can be done. To have photography made from altitudes of 40,000 feet has become commonplace, and special aircraft today can carry sensing equipment to much higher altitudes.

Recently, a new dimension has been added. This is remote sensing from space. Earth-orbiting satellites can be equipped with several kinds of sensors, including cameras, to image phenomena 0" earth.

Imaging from space partakes of the same kinds of problems as imaging from aircraft, and poses the additional problem of transmitting the data to receiving stations on earth; but imaging from space also has two important advantages. One is that synoptic images, including photographs, are possible for large areas--thousands of square miles. The second is that repetitive sensing of the same area is possible 0" a regular basis.

Remote sensing systems involving combinations of space craft, aircraft, and on-the ground observations by people or instruments can be expected to evolve. The possible combinations are many.

Proposals for Investigating Application of Remote Sensing

Two proposals have been made and, hopefully, will be implemented in fiscal 1972.

The objective of one proposal is to determine if, by use of up-to-date remote sensing techniques, ways can bc found to make soil surveys faster, more accurate, and at less cost. The focus will be on areas, such as the flatwoods along the Atlantic and Gulf Coasts, where visible clues to soil boundaries are obscure or "on-existent, on the ground and as well as on conventional panchromatic photography. The proposal is:

a. To select a few areas, a few hundred acres in size, to be sensed by:

(1) Panchromatic photography
(2) Color
(3) Modified infrared (black and white)
(4) Infrared (false color)
(5) Also to consider sensing by:

(a) Radar
(b) Microwave

b. To have the research areas sensed several times, at several altitudes and scales, to determine what time of year, or what combination of dates, will yield the most usable information. To have the areas sensed in winter, spring, summer, and autumn hss been sugges ted.

c. To make highly detailed on-the-ground investigations to determine "hat soil boundaries, and/or soil characteristics, are revealed by the airphotos or combinations of airphotos.

The second proposal is to test outputs from the first Earth Resources Technology Satellite (ERTS-A). This proposal is to test the use of these outputs not only for possible use i" soil surveys but for possible use in other SCS activities to". The satellite is scheduled to be sent aloft i" the spring of 1972. This satellite will be at a" altitude of "early 500 miles, will be in polar orbit, and will retrace identical paths every 18 days for a scheduled lifetime of 1 year.

This satellite will be equipped with three return beam vidicon cameras (RBV's) end a multispectral scanner. The RBV's will sense the following bands:

,475 - ,575 microns (blue-green)
.580 - .680 microns (red)
.690 - .830 microns (infrared)

The multispectral scanner will scan the following bands:

0.5 - 0.6 microns
0.6 - 0.7 microns
0.7 - 0.8 microns
0.8 - 1.2 microns

The outputs will be made available to the SCS in photographic-like images in square frames of area 100 miles by 100 miles. Ground resolution probably will be on the order of 200 to 300 feet.

The area selected for study is the Texas Coastal Basins (Figure 1). This area was selected because it is a relatively small area (31,500 square miles) in which many Service activities will be underway in 1972. These include a USDA cooperative comprehensive river basin study (Type IV), several small watershed projects, several soil surveys, and several RC&D projects. The proposal is to have ERTS outputs tested and evaluated for potential use in all these activities. Many details are yet to be worked out, both administrative and technical.

Also, during the lifetime of ERTS-A, NASA will sense a substantial part of the area (vicinity of Houston) with a variety of sensors mounted on aircraft so that imaging from aircraft as well as from spacecraft will be available if we should want it.

In addition to the modest testing by SCS, ERTS outputs will be tested for many applications in many places by non-governmental as well as governmental agencies. Among these will be many state agricultural experiment stations, several of which will be testing the possible use of ERTS outputs for soil mapping.

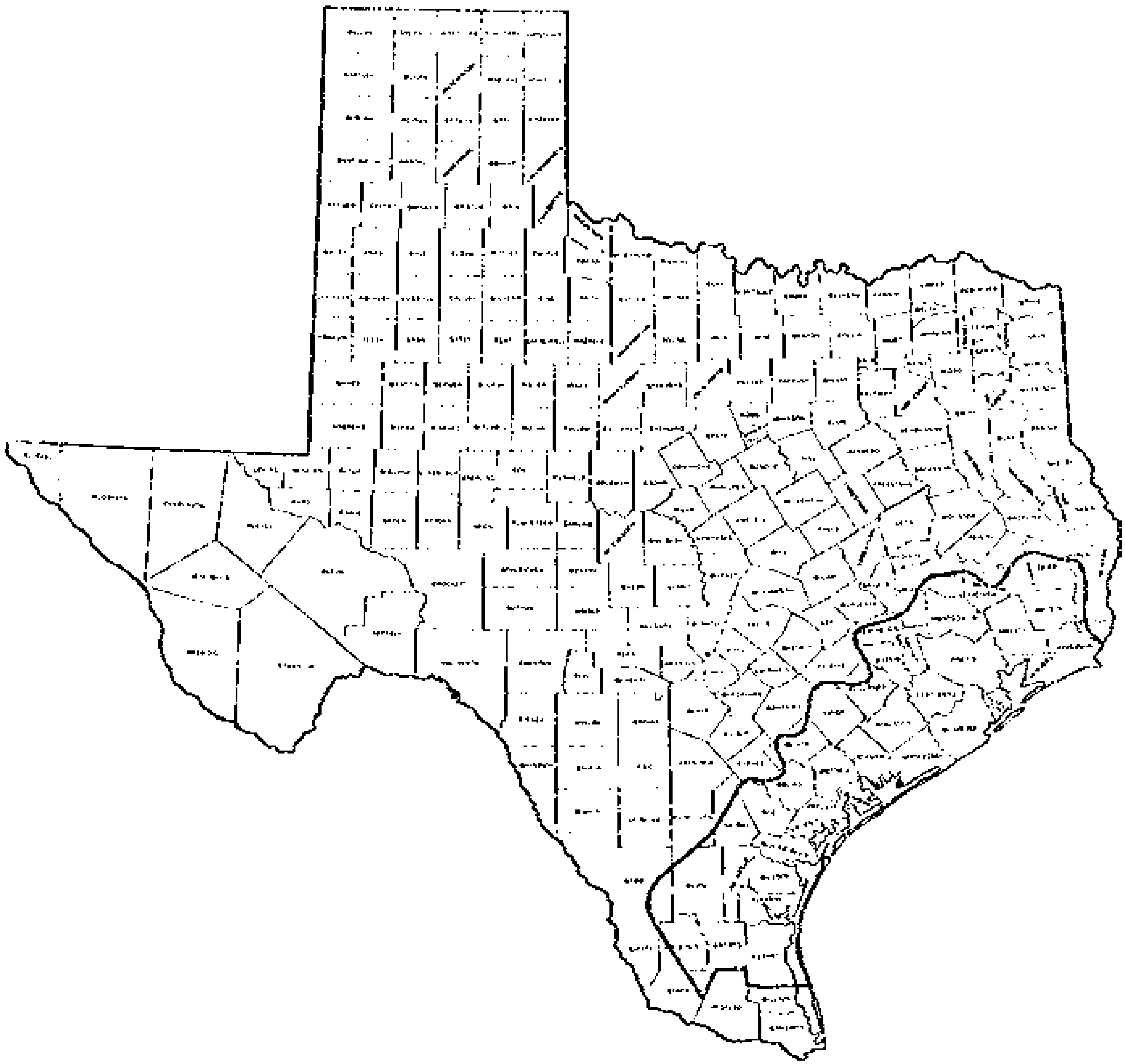
Conclusion

The extent to which remote sensing, in addition to good panchromatic photography, can be used to advantage in soil surveys is yet to be determined. Certainly field work cannot be eliminated. Soils must be examined to depths of 5 or 6 feet. These depths are still far beyond the reach of any remote sensor or combinations of sensors. Yet, clues to many, perhaps most, soils do appear at the surface. It is these clues, many of them subtle and obscure, that the field soil scientist searches for and uses for drawing soil boundaries. It is these clues that enable him to make accurate soil maps without excessive digging or augering; and it is by revealing these clues that remote sensing can contribute most to soil surveys.

TABLE 1 Wavelength and Frequency Ranges of Operation for Remote Sensors 1/

Spectral Region		Wavelength	Frequency	Common Applicable Imaging Sensors
Microwave				
Active (radar) / Passive	Decimeter (UHF)	10-100 cm	3×10^{8} to 3×10^{9}	Scanning antennas with radio-frequency receivers
	Centimeter	1-10 cm	3×10^{9} to 3×10^{10}	
	Millimeter	0.1-1 cm	3×10^{10} to 3×10^{11}	
Optical				
Infrared	Far Infrared	8-1,000 μ	3.75×10^{13} to 3×10^{11}	Scanners with infrared detectors
	Intermediate Infrared	3-8 μ	1×10^{14} to 3.75×10^{13}	Various image tubes (not very satisfactory)
	Near Infrared	0.780-3 μ	3.85×10^{14} to 1×10^{14}	Photographic film to approximately 1 μ Scanners with infrared detectors Various image tubes
Visible		0.380-0.780 μ	7.89×10^{14} to 3.85×10^{14}	Photographic film Scanners with photomultiplier detectors Television
Usable	Near Ultraviolet	0.315-0.380 μ	0.952×10^{15} to 7.89×10^{14}	Photographic film (quartz lenses) Scanner with photomultiplier detectors
	Middle Ultraviolet	0.280-0.315 μ	1.08×10^{15} to 0.952×10^{15}	Image-converter tubes
Far Ultraviolet		0.010-0.280 μ	3.0×10^{16} to 1.08×10^{15}	These wavelengths do not penetrate the earth's atmosphere significantly so are not useful for agricultural remote sensing
Vacuum Ultraviolet		0.004-0.010 μ	7.5×10^{16} to 3.0×10^{16}	

1/ Holter, Marvin R., Bair, M., Beard, J. L., Limpers, T., and Moore, R. K. Imaging with Nonphotographic Sensors, pp. 73-163, in Remote Sensing with Special Reference to Agriculture and Forestry by the Committee on Remote Sensing for Agricultural Purposes, Agricultural Board, National Research Council, National Academy of Sciences, Washington, D. C., 1970, 424 pp.



STUDY AREA
TEXAS COASTAL BASINS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

Figure 1. Delineation in gray is the approximate area proposed for testing by SCS of ERTA-A outputs.

SOIL SURVEY AND LAND MANAGEMENT
WEYERHAEUSER COMPANY

Thomas A. Terry *

Today, more than any other time in history, people are beginning to realize that there is a limited amount of land on the earth from which we must obtain all of our needs. Only recently have we in the United States really felt the pain of losing much of our frontier character. Because of the value placed on land today for recreation, industry, housing and food, and fiber production, it becomes increasingly important to manage public and private land holdings as wisely as knowledge permits.

Large land holders have found that much responsibility goes along with owning and managing land. No longer can one do anything he wishes with his land. One must manage land today with public as well as private goals in mind. For a large wood products oriented company like Weyerhaeuser Company, management of the land is predominantly for wood production. Because of the many other land use pressures, i.e. housing, industry, agriculture, etc., one must be aware of all alternatives.

Weyerhaeuser Company's ownership consists of 2.2 million acres in the fir region of Oregon and Washington; .6 million acres in the western pine region of Oregon; and 2.7 million acres in the southern pine region of North Carolina, Mississippi, Alabama, Oklahoma and Arkansas. With a land ownership of 5.5 million acres one can see how important it would he to know as much about Company land holdings as possible.

Weyerhaeuser West Coast Soil Survey

Because of the need for better land management and higher wood yields, Weyerhaeuser has maintained a Forestry Research Center in Centralia, Washington. This Research Center is staffed by sixteen scientists who work on projects related to forest management, forest regeneration, forest soils and tree genetics (tree improvement) on the Company's western holdings.

One of the major contributions of their research over the years has been the development of a soil survey system which types the land as to its productivity and groups areas which can receive similar management practices.

The principles on which the soil survey was made are based on how the land was formed, and how its rocks were formed. Soils in this area were formed by either volcanism, sedimentation or- glaciation. Over many years these lands have been shaped by uplifting processes, and worn down by erosion processes i.e. wind, water and/or ice, and the effects of gravity. These land forms today are clearly visible. Depending on the soil parent material, the prevailing climate and supporting vegetation, soils of different characteristics have developed on each of the different areas.

Extensive soil and site studies throughout western Washington and Oregon have shown that timber productivity is highly correlated with certain soil characteristics. The four soil variables which influence growth performance most are -- soil depth, topsoil depth, soil texture, and elevation. Knowing these four variables one can very accurately predict what the productivity of a given site will be. The soil surveyor in a given western region knows that certain soil types are associated with a particular form and he can type accordingly. Because these four soil characteristics are so closely related to land form, a soil survey in many cases can he done completely from aerial photographs.

Knowing what each acre of Company land will produce is a real management tool which can only be obtained through some type of soil survey system. Other types of information can also be worked into a soil survey including land use, harvesting methods, thinnability, soil engineering, and windthrow hazard. When all of this information is made available to a land manager, it is easy to see how important decisions can be made with more confidence.

Weyerhaeuser Company's Soil Survey Needs in the South

The only complete soil survey information that we have on Company land is on our western holdings. Although much soil and site work has been done in the south, and work is progressing in making woodland soil survey interpretations. not much of our 2.7 million acres in the southern pine region has actually been surveyed. The present soil surveys also are inadequate for our needs. They give a description of the soil hut no growth and yield information is available

* Research Forester, Weyerhaeuser Company, Southern Forestry Research Center, New Bern, N. C.

to go along with it.

Weyerhaeuser Company's High Yield Forestry program which combines intensive site preparation with genetically improved varieties of trees has shown the need for a more comprehensive soil survey, especially in the coastal plain of North Carolina. Elaborate drainage systems have greatly improved site productivity on certain sites, Intensive site preparation has removed competing vegetation and increased usable wood yields. Fertilization of some sites with phosphorus has dramatically increased growth response. Since private forestry operations have to make a profit, managers need to know what each land type will produce under different site preparation and management system;. A soil survey which combined land productivity, drainage requirements, fertilizer prescriptions and harvesting methods, etc. could mean the difference between making a profit or losing money m scare sites.

Because we are going to be relying on cur plantations soon for most of our wood requirements, the yields of these new plantations will determine just how much the manufacturing plants can be expanded and how much can be harvested each year to insure a continuous wood supply. If one knows what each soil type can produce, these decisions can be made with much more certainty.

Another very important soil survey need in North Carolina presently concerns characterizing those sites where good phosphate fertilizer responses have been obtained. On some sites very impressive growth increases have been achieved with the application of 300 lbs. triple superphosphate prior to planting, and in established plantations. If we could more accurately identify these responsive sites, a" operational fertilization program would be much more efficient.

Soil Survey needs in Mississippi-Alabama and Arkansas-Oklahoma present different problems from those in North Carolina but are equally as urgent. Soil Surveys need to be developed which take into account site improvement factors including water conservation practices and fertilization. Growth and yields need to be expressed on 10-25 year terms in relation to these improvement factors and the soil type.

Weyerhaeuser's Southern Forestry Research personnel in Hot Springs, Arkansas, and New Bern, North Carolina, will be trying to solve some of these problems. Currently, much effort is being expended in obtaining growth and yield information as related to various site preparation and cultural practices including drainage, bedding, fertilization, and precommercial thinning. The next step is to spread the "hard data," and this can best be dme by tying this growth and yield information to a given soil type.

LABORATORY CHARACTERIZATION OF SOILS IN THAILAND

Harold Parkinson*

All of you are familiar with the location of Thailand, Laos, Cambodia, and South Vietnam. These countries have one resource in common; and that is the Mekong River-a river which is larger than the Columbia. The ultimate goal is to control the Mekong River with a series of dams so as to develop hydroelectric power, prevent floods, and provide a source of water for irrigation. My first slide (Slide 1) shows the location of these countries and the Mekong River. It will be of interest to you to know that when the Mekong River is in flood stage during October and November, most years, the flooded area is 90 miles wide in parts of Cambodia and South Vietnam. A floating rice has been developed which can grow in up to 17-foot depth of water for use along this river.

In 1964, the Bureau of Reclamation was requested to study the feasibility of building a dam on the Mekong River near Vientiane, Laos, and to evaluate the prospects for irrigation in this vicinity. The selected damsite was called the Pa Mong site. Some slides follow:

Slide 2 - A" artist's conception of the Pa Mong Project
Slide 3 - Pa Mong dam data comparisons
Slide 4 - Contributors to Mekong Development Program
Slide 5 - Mekong - Chronology of events
Slide 6 - study area map

In the preliminary studies, starting in 1964 a subreconnaissance land characterization was made which indicated that there would be about 5 million acres of land suited to gravity irrigation.

Following the completion of the subreconnaissance land characterization study in 1967 over the entire potential project area, a feasibility grade land classification study was made on an area-the Pa Mong Dam. This was an area delineated by subreconnaissance as having the best potential for early development. The feasibility studies associated with this stage development plan have bee" termed Stage I studies. They encompass an arable land area of 54,390 hectares (134,000 acres) of which 11,990 hectares are located in Laos, and the remaining 43,400 hectares are in Thailand. Exclusive of the storage facilities, approximately 700 hectares within the Stage I area could be readily irrigated if a pumping system were installed.

The Stage I study area land is located on natural levees and flood plains along the Mekong River, on the flood plains of tributary rivers, and on upland areas. The soils occur within the broad groupings of Entisols, Inceptisols, Ultisols, and Alfisols, The major land area is composed of Ultisols and Alfisols and can be characterized as strongly weathered, mottled, very acid, and containing significant amounts of exchangeable aluminum in surface horizons with increasing amounts at depth. Both surface and internal drainage characteristics are poor so that rice is best suited for crop production on most of the area.

Our land classification activities had a dual purpose. The primary one was to determine the suitability of the lands for sustained irrigation; the other purpose was to train counterpart Thailand Nationals on methods of land classification. Therefore, in many of the slides, you will observe our counterpart workers who were learning through actual work assignments.

I will now show you a few slides relating to field conditions and land classification activities.

Slide 7 - Thrailkill with auger and plane
8 - Helicopter for remote area
9 - Girl turning auger
10 - Farmer holding Cassava or tapioca root
11 - Planting rice plants by hand
12 - View of master site soil pit
13 - Salinity problems
14 - Aerial View 1 - Note trees on ridges
15 - Aerial View 2
16 - Aerial View 3
17 - Aerial Vim - Closeup showing paddies
18 - Airport at Udon Thani

*Bureau of Reclamation, United States Department of the Interior, Denver, Colorado

Slide 19 - Typical farm implements
20 - Freshly planted rice
21 - Papaya tree
22 - water buffalo - Work horse of Thailand
23 - Typical brush and tree vegetation
24 - Suan or mound type irrigation
25 - Irrigated cucumbers
26 - Sprinkler irrigation
26a- Boat and sprinkler equipment

Much of the soil appraisals relating to suitability for irrigation was based on laboratory data. Pits were dug to 3-meter or more depth throughout the area to serve as master sites for determining the various physical and chemical soil properties associated with irrigation Suitability. Routine soil sampling was also done during the land classification program. Many thousand samples were tested.

In addition to laboratory data and field observations relating to productivity and land development costs, drainage evaluations were very important in determining suitability for irrigation. Land areas were separated into classes indicating they were suitable for the irrigation of rice, irrigation of upland crops, or not suitable for irrigation. The drainage evaluations were particularly important in determining whether a soil could be used for upland crops or whether it should be relegated to a rice category. Depth to barrier, which would prevent downward percolation and relate to internal drainage control cast, was an important drainage factor. If a barrier layer, such as an indurated hardpan, dense textural B horizon, or slowly permeable clay occurred within 7 feet of the surface, the land was considered as not suited to upland crop production under irrigation. Most of these lands were placed in a rice category.

Soils laboratory data were important in evaluating the anticipated relative productivity level for lands considered suitable for irrigation. We were fortunate in being permitted to develop an unusually fine soils laboratory in Bangkok. This laboratory was equipped to make nearly any soils analysis required. The laboratory has about 9,500 square feet of floor space and is equipped to make quantitative analyses by flame emission, and atomic absorption spectrophotometry plus the usual colorimetric, potentiometric, titrimetric, and gravimetric techniques. During the peak of work, the staff consisted of eight soil scientists, six chemists, and eight laboratory assistants. All but two were Thailand Nationals. The laboratory did not have x-ray and differential thermal analysis equipment, so all clay mineralogy tests were conducted at our Engineering and Research Center in Denver. I have a few slides showing interior views of our Bangkok laboratory which I will show.

Slide 27 - Model 303 Perkin Elmer Atomic Absorption Spectrophotometer
28 - Coleman Flame Photometer
29 - Fragmented hydraulic conductivity equipment
30 - Same as 3, but closeup - Note tight soils
31 - Settling volume equipment with Thai girl - Some high volumes
32 - Soil extraction equipment - Thailand
33 - lady chemist in Thailand lab - Particle size analysis
34 - Laboratory oven
35 - Water extraction equipment
36 - Water extraction equipment - Another view
37 - Scientific journal rack behind fragmented hydraulic conductivity
36 - Typical laboratory report form
38a- Routine analyses run

Clay mineralogy was found to be important to soil productivity evaluations. Except for the most recent soils near the Mekong River, such as the Chiangmai and Phimai soil series, the clay minerals of the majority of soils consisted of about 80 percent quartz, 10 percent kaolinite, 3 to 5 percent mixture of montmorillonite and illite, and the rest miscellaneous. Recent soils, such as the Phimai, have clays with about 30 percent quartz, 15 percent kaolinite, and around 40 to 50 percent of montmorillonite and illite.

Because of the lack of mineralogical testing equipment, our Bangkok laboratory developed some alternative tests to indicate the type of clay minerals. Surface area tests using ethylene glycol were found to be particularly useful. I will show you a few slides relating to this.

Slide 39 - Specific surface as related to mineralogy
40 - Correlation of surface area versus clay mineral
41 - CEC at pH 8.2 (NaAc) versus surface area
42 - 15-bar percentage versus surface area

Low soil fertility was very important in the evaluation of the soils for irrigation suitability, because of such factors as low-cation-exchange capacity, low-base saturation, large amounts of exchange and titratable acidity, excessive amounts of exchangeable aluminum, scarcity of minerals capable of realeasing plant nutrients on weathering, and presence of sesquioxides which can interfere with nutrient availability. Therefore, a large percent of the laboratory testing was directed toward an evaluation of fertility.

Cation exchange capacity is a very important factor relating to productivity because a soil must have the capacity to retain fertility over a reasonable period of time or every irrigation would require the addition of a nutrient solution. The adopted laboratory method was found to make quite a difference on the value of CEC for some soils. After an analysis of available data, it was concluded that the CEC value at soil pH was more useful than the conventional CEC at pH 8.2.

Effective CEC, which is the CEC at soil pH, was found to relate closer to productivity than other CEC methods. The CEC in this method is determined from the sum of exchangeable calcium, magnesium, and sodium plus the exchange acidity obtained by leaching a soil with 1N KCl. All of the good productive soils had a high effective CEC value.

CEC obtained with NaOAc buffered to pH 8.2 was also run on most samples. Its value is generally slightly higher than the effective CEC. It was run by saturating a soil with sodium acetate and removing the sodium with ammonium acetate.

Charge characteristics--The "se of barium chloride with and without triethanolamine was also used as a method for evaluating cation exchange capacity using barium as the index ion. In addition, the acidity obtained by titration of extracts from these methods was found useful in measuring negative-charge sites. These measurements were particularly useful in evaluating the type of clay minerals. Concepts were developed by Dr. Mehlich and his associates.

a. Permanent-charge acidity or permanent-charge cation capacity, termed CEC_p, is a measure of the acidity associated with negative-charge sites resulting from isomorphous substitution. It is determined by leaching a soil pretreated with acid to remove metal cations with 0.6N neutral unbuffered $BaCl_2$ solution. The barium is subsequently replaced by calcium and barium is measured. Good productive soils were found to contain over 50 percent permanent-charge CEC.

b. Total negative--e aciditv or the total cation exchange capacity (CEC_t), is measured by the amount Of barium retained from a barium chloride triethanolamine ($BaCl_2$ - TEA) solution buffered at pH 8.2. The soil is pretreated with acid as with the permanent-charge cation-exchange-capacity test, CEC_p.

c. Variable-charge acidity or variable-charge cation exchange capacity (CEC_v), is obtained by subtracting thee CEC_p (permane ie CEC_t (total negative-charge acidity). It is a measure of charge contribution9. from organic matter, amorphous alumino silicates, and possibly clay minerals of low-isomorphous substitution; i.e., the 1:1 type of clay minerals.

d. The maximum-negative charge (CEC_m), possible to develop in a soil is determined by the barium retained from a $BaCl_2$ - TEA Solution by a soil pretreated with phosphate. It is an indication of the influence of hydrous oxides and possibly of the relative proportion of 1:1 clay minerals.

e. The anion exchange capacity (AEC), was estimated by the amount of H_2PO_4 retained after saturating the sample with calcium dihydrogen phosphate $Ca(H_2PO_4)_2$ and then removing the excess with a $CaCl_2$ solution.

Some slides will show relationships found to be useful.

Slide 43 - 15-bar percentage versus effective CEC
- 44 - Titratable acidity, $BaCl_2$ - TEA, at pH 8.0 plus extractable bases with 1N KCl versus CEC at pH 8.2 (NaAc)
- 45 - Extractable bases plus exchange acidity (effective CEC) versus CEC with unbuffered $BaCl_2$ (permanent charge CEC_p)
- 46 - Correlation of rice yield versus effective CEC

Acid base status was a very important consideration in soil suitability evaluations. Except for the river levees, the soils are generally too acid for the satisfactory production of acid-sensitive crops. Poor crop growth is not believed to be due to acidity per se but is attributed to aluminum and manganese toxicities and deficiencies of calcium, magnesium, and molybdenum.

Because of an increase in pH when submerged and under anaerobic conditions, the pH value of soils for growing wetland rice has different implications than that of upland soils. Slide 46a shows changes in pH brought about by inundation. The change in pH under anaerobic conditims is a result of reduction of ferric iron, release of hydroxide ions, precipitation of aluminum hydroxide, and adsorption of ferrous iron by the clay minerals. Active or easily reducible iron and manganese are believed to be important in this reaction. Acid sulfate or "cat" clays were not found in our project area. Some researchers indicate that they can be identified by noting reduction of pH when hydrogen peroxide is added.

Total acidity is the sum of the exchange acidity with KC1 plus the titratable but nonexchange acidity (pH dependent). For evaluation of lime requirements, most investigators have concluded that only enough lime should be added to neutralize the exchange acidity. Therefore, we prefer the exchange acidity measurement to total acidity. It is well known that detrimental effects can result when coarse-textured soils with a low total cation exchange capacity (CEC_t) and a relatively large variable cation exchange capacity (CEC_v) are limed in excess of their exchange acidity. The pH of soils as measured in 0.01M $CaCl_2$ has been found to be strongly influenced by relatively small changes in exchange acidity when complete base saturation of the effective cation exchange capacity is approached. Some slides will illustrate some of the relationships we have found.

Slide 47 - Curve - Percent base saturation versus pH in $CaCl_2$
48 - Four curves as above - Pa Mong, Nam Mun, Brazil, and Korea
49 - Curve - Neutral salt exchange acidity versus pH in 0.01M $CaCl_2$
50 - pH in 0.01M $CaCl_2$ versus pH in water 1:1
51 - pH in 0.01M $CaCl_2$ versus pH in 1N KC1
51a- pH in $CaCl_2$ versus three other curves

Special field and greenhouse studies were also made in support of our land classificatim activities. One-ton bulk samples from each of the four major soil series have been collected for greenhouse studies on rice production. Slide 52 shows the rice growing in a greenhouse. These tests are being made to examine nutrient requirements associated with various ranges in exchange acidity and active iron. Data suggest possible detrimental effects of active iron.

As a result of our laboratory studies and field observations of crops growing during the rainy season, we have developed a set of land classificatim specifications for tropical soils which we believe to be generally applicable in tropical areas such as Thailand. These are shown in the following slide, Slide 53.

Using similar specifications in our Thailand studies, these land classifications result:

Arable lands	Percent
Class 1 - 580 hectares	1.0
Class 2 - 5,590	10.0
Class 1R - 16,510	30.0
Class 2R - 31,710	59.0
54,390	

Typically, the Class 2 rice soils, which make up the bulk of the arable lands, have effective cation exchange capacity values ranging from 3 to 5 meq/100g in the surface soils. Of this CEC, the exchange acidity varies from 1.5 to 3.0 meq/100g, of which all but about 0.5 meq/100g is exchangeable aluminum. The soil pH in 0.01M $CaCl_2$ ranges from 4.2 to 5.0 in the surface 30 cm and decreases with depth.

The very best soils, which make up only 1 percent. have pH values in 0.01M $CaCl_2$ varying from 6.0 to 7.0. The root zone depth has very little exchange acidity and no exchangeable aluminum. The effective cation exchange capacity exceeds 10 meq/100g in the surface horizon. Base saturation is generally over 90 percent. In addition, the soils are well drained and have no subsurface drainage barrier within 210 an.

The rest of the arable lands occur within the limits of arability as shown by the specificatims just observed.

The next slide (Slide 54 - Bar graph of net income versus land classes), shows a bar graph of actual net farm income on paddy rice as related to our land classes. Results are based on about 45 sites for which production during the rainy season was measured.

Two of our typical laboratory reports are included for your information. Table No. VIII-9 is for a high-quality rice soil and the soil series is Chiangmai. We can discuss these results as related to some of the slides which have been shown.

USEFUL. COMMENTS ON LABORATORY DATA

1. The Chiangmai series is a productive and well-aggregated soil as evidenced by favorable hydraulic conductivity at all depths, favorable settling volume, favorable pH, favorable CEC, and favorable available phosphorus content. Permanent-charge CEC (CEC_p), while less than 50 percent in the upper horizon, exceeds 50 percent at all other depths. Since this is a recent alluvial soil, it may man a different source of materials for 0 to 16 cm.

2. The unnamed series "B" soil data on other sheet is Class 2 because of slowly permeable and unstable structure below 60 cm, low available phosphorus, and low effective cation exchange capacity. The permanent-charge CEC (CEC_p), is less than 50 percent in three out of the upper five horizons suggesting a preponderance of highly weathered clay mineral.

3. Exchangeable aluminum, except for 28- to 53-cm depth on the unnamed soil, is favorable. Generally, values of 0.5 meq/100g or less are favorable for all crops. Values from 0.5 to 2.0 have minor effects, depending on the crop, and values above 2.0 generally are quite toxic, especially in upper root zone. Crops which are very tolerant of exchangeable aluminum include sugar cane, cassava, peanuts, kenaf, and rice. The amount of base saturation and CCC values relate to aluminum toxicity. Generallv, soils with over 75 percent base saturation are less toxic even in presence of 2 or 3 meq of aluminum.

CORRELATION DATA - UNNAMED SOIL - 19-28 cm - 2RS

Slide	Correlation test	Item	Values
55	1. Base saturation versus pH in $CaCl_2$	Sum of bases	4.92
		Effective CEC	5.3
		pH in $CaCl_2$	5.5
		Predicted base sat. from curve	95
		Actual base sat.	93
56	2. Exchange acidity versus pH in $CaCl_2$	pH in $CaCl_2$	5.5
		Predicted exchange acidity	0.5
		Actual exchange acidity	0.4
57	3. 15-bar percentage versus effective CEC	15-bar percentage	5.0
		equation $Y = 0.773X +$	0.58
		Predicted CEC	3.9
		Actual effective CEC	5.3
58	4. Titratable acidity plus bases versus CEC_t (CEC at pH 8.2 $BaCl_2$-TEA)	Titratable acidity	1.71
		Extractable bases	4.32
		sum	6.63
		Predicted CEC_t	5-6
		Actual value	5.6
59	5. Titratable acidity $BaCl_2$-TEA plus bases versus CEC at pH 8.2 in sodium acetate	Titratable acidity	1.71
		Extractable bases	4.92
		sum	6.63
		Predicted CEC	6-7
		Actual value	7.0

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service

NATIONAL TECHNICAL WORK-PLANNING CONFERENCE OF THE COOPERATIVE SOIL SURVEY
Charleston, South Carolina, January 25-28, 1971

REPORT OF THE COMMITTEE ON TECHNICAL SOIL MONOGRAPHS, BENCHMARK SOIL STUDIES, AND SOIL SURVEY LABORATORY INVESTIGATIONS

Background

This is a new committee formed to consider the activities of technical soil monographs, benchmark soils and soil survey laboratory investigations. These three activities have many objectives in common and have bee" combined so that we can jointly work on problems that are common to all. It is well known that our total resources for laboratory work in the National Cooperative Soil Survey are limited. We cannot discuss benchmark soils, technical soil monographs and soil laboratory work separately and utilize most efficiently our limited total resources for laboratory work.

Regional Committee Reports

TECHNICAL SOIL MONOGRAPHS

The Northeast Region was the only committee Lo report on progress on technical soil monographs. Ten states that responded in that region all indicated no progress. It was indicated all states are accumulating data, some of which could eventually be incorporated in technical soil monographs, but little of these data are being gathered specifically for technical monographs. Some of the states indicated that it is difficult to know what additional data are needed until those data available are Pulled together. Some feel that automatic data processing for laboratory data (ped"" data file) may serve the needs in lieu of actual technical soil monographs.

The Northeast Regional Committee responded favorably to the proposed Monograph of Soil Taxa as set forth in the 1969 National Technical Work-Planning Conference report of the Committee on Technical Soil Monographs. This committee expressed a feeling that monographs of soil taxa could utilize ADP more readily than technical soil monographs and could be prepared more efficiently. However, they expressed concern that this is one more program for which there is a lack of time and competent personnel to accomplish the job.

Progress on Technical Monographs

This report is largely redundant of the 1969 National Committee report with little new development to report.

1. The technical soil monograph of the Nashville Basin (Max Edwards, et al) has been completed and after three years is still in the Information Division for final editing for publication. The outlook for an early completion of the edit is very pessimistic with the high priority now being placed on published soil surveys.

2. The technical soil monograph of Central and North Texas (Oaks, et al) still is in need of a complete write-up of the laboratory data. Some parts of this report are now obsolete and need to be updated. There is need of a modern classification of the soils.

3. The technical soil monograph of the Red River Valley of Minnesota. North Dakota. and South Dakota is still in Progress.

4. A soil monograph of the soils of the Mississippi Delta is in progress as a project of the Southern Regional Soil Research Committee. The target date for completion is July 1, 1971.

It is the opinion of the National Committee, for all practical purposes, that the program of technical monographs has reached a dormant stage and that little will be done on the specifics of new monograph preparation until the backlog of soil surveys is published. This committee 'eels that we should place our efforts (1) to publish the monographs that are complete and to complete the ones now in pi-ogress and (2) to assess the impact of the Automatic Data Processing on the preparation of technical reports. It is suggested that the technical reports of four or five years hence will consist largely of pre-formated information, mostly retrieved from the computer. They will not be so much written as assembled. Through the use of ADP we will assemble taxa reports by retrieval of information in computer storage that will reflect the efforts of many soil scientists over broad geographic areas. The reports will conceivably take the form of super benchmark soil reports.

Committee Recommendations

1. That the National Work-Planning Conference of the National Cooperative Soil Survey support the timely publication of completed technical monographs and the completion and publication of technical monographs now underway.

2. That the National Committee dealing with technical monographs evaluate the potential application of ADP in the preparation of technical monographs and recommend changes in techniques and format where deemed necessary to complement the application of ADP.

BENCHMARK SOILS

The Northeast Regional Committee prepared an update list of benchmark soils. The list was arranged to show under each state the benchmark series with type location in that state. The conference adapted the recommendation that each state select its benchmark soils from the series for which it has the type location.

The Southern and Northeast Regional Committees discussed the relation of benchmark soils to classes in the new soil taxonomy. It was agreed that the soil classification system should be a" important consideration in selecting benchmark soils. The family level especially multiseries families would generally represent large geographic areas and would satisfy the important criteria of extent. The Northeast committee rejected a proposal that the benchmark soil selected to represent a family be the series that provided the "short name" for the soil family. The rejection was largely based on the belief that the dual use of a word for a series name and as a "short name" for a family would be confusing to soil scientists not directly involved with soil classification. Roth committees agreed that generally only one series be selected from each multiseries family.

Both the Southern and Northeast committees indicated a lack of a" inventory of available laboratory data. A large amount of data is already collected on some benchmark soils. This varies from very little data on some soils to "early complete data for others. It was recognized that a complete catalog of available data was needed as a guide to priority of sampling.

The National Committee agreed chat generally only one series be selected from each multiseries family. The National Committee also thinks that the definition of benchmark soils should consider whether hard-to-get data are available. An example would be in the field hydrology of the soil. It is easy to obtain standard characterization data. But the kinds of measurements obtained at the various ARS hydrology study areas are extremely expensive and rare. Unless the soil on which the study has bee" performed is a "really oddball" we should consider it as a benchmark sail. even though of modest areal extent.

The Southern Committee made recommendations to update the guidelines for selecting benchmark soils. They are attempting to get a better representation of soil families. The National Committee looked with favor on these recommendations and have incorporated them in their recommendations.

The report of the Southern Committee on soil survey workload contains a comment by Dr. Buol on setting aside areas as benchmark sites that will remain undisturbed. Your committee discussed this proposal and considered it LO be worthy of consideration. It was agreed that it is very difficult to relocate many benchmark soils. A few sites are destroyed and lost by disturbance. The committee considered the possibility of establishing benchmark sires through the geomorphology projects, ARS hydrology research areas and Agricultural Research stations. Certainly these are potential areas. Methods of pinpointing type locations were discussed. One method suggested was to complement a detailed location description by use of a magnetic device.

A metal block could be buried and traced by use of a mine detector. Another suggestion was to develop a legal description by use of triangulation survey. A file of photographs taken from different angles might also prove to be useful in finding the site.

Committee Recommendations

1. procedure for selecting benchmark soils

1.1 Each state select its benchmark soils from the series for which it has type location and responsibility for the series description.

1.2 Each state list should be reviewed and approved by a standing Regional Technical "ark-Planning Committee.

1.3 The soil classification system should generally be used to select benchmark soils.

1.31 Taxa should be selected that represent a large geographic area. An exception would be for select soils for which there are hard-to-get data available. In such cases, a modest areal extent would be acceptable.

1.32 Generally only one series will be selected from each multiseries family. The series that is used to name multiseries families is a likely candidate for benchmark soil.

1.33 Taxa should generally be selected from which data can be projected to the most soils. Data from soils in Typic subgroups, for example, can be projected to more soils than data from soils in Vertic subgroups.

1.34 The number of benchmark soils should be kept small enough to concentrate on the key soils. in order to get the data within a reasonable time.

2. That a standing Regional Committee be established to approve state list of benchmark soils. That this committee check the benchmark soils now on lists from the four regions to see how many different soil families are represented. There may be big gaps where we have no soils data to represent broad and important areas in our new classification system.

3. That Regional Work-Planning Conference prepare an inventory of available laboratory data that has been done by the soil survey laboratories, the experiment stations and other sources so that a plan of operation can be made to complete the work within the next few years. (See Attachment 1 far suggested form for reporting benchmark soil characterization inventory.)

4. That the National Work-Planning Conference continue to support the preparation and publication of benchmark soil reports and promote the use of ADP in preparing the reports.

5. Regional Committees take the leadership in programing for benchmark sites and provide the National Work-Planning Conference with suggestions for implementation, or for rejection of the proposal.

SOIL SURVEY LABORATORY INVESTIGATIONS

Three 1970 Regional Technical Work-Planning Conference Committee reports on Soil Survey Laboratory Investigations were reviewed. The Western Region did not have a report.

The three committees (S, NC and NE) reviewed the list of laboratory studies developed by the 1968 Regional committees and appropriate amendments made. The Northeast committee recommended that the experiment stations and SCS intensify their studies of tidal marsh. They cite that in the past the kinds of tidal marsh have not been differentiated because of difficulty in mapping and lack of interest or request to have the materials differentiated. Now more and more, federal, state, and private groups are asking for specific information an tidal marsh areas. It was recommended that the Principal Soil Correlator for the Northeast and the Head of the Beltsville Soil Survey Laboratory take leadership in working with the states in developing a regional project for characterizing the morphology and composition of fragipans. IL is recommended that the project be outlined to make maximum use of graduate students in the study.

The Northcentral committee discussed the revision of Soil Survey Investigations Report No. 1 that is now underway in Lincoln. The publication presently consists of the methods used, past and present, by the soil survey laboratories. The committee was of a" agreement that the scope of the report should be broadened to include all the laboratories in the cooperative soil survey. It was recommended that state laboratories submit methods that they are using but arc not indexed in SSIR No. 1 to Lincoln. They can be assigned a number or included under an existing "umber if the method is similar to one in use.

The Southern Region reported no increase in requests for laboratory determinations. The committee, however, recognized most of the requested data to be routine characterization to aid placement of soil and very little or any investigational studies. Additional research needs were discussed that would strengthen the understanding of soil genesis and those characteristics of soils that influence their behavior.

Discussion and Recommendations by Committee

The National Committee considered the details that should be included in the state soil survey Plan of Operations. It was the consensus of the committee that the present detail show" on most plans of operations is not adequate. It is essential chat we develop closer relationship of both soil survey and experiment station laboratory schedules with field operations. The plan should indicate specifics about soil survey laboratory investigation needs projected over a three-year period and show soils to be sampled, classification. proposed sampling dates and who will do the work. This should provide for a better means of projecting laboratory workloads and setting priorities for sampling on a regional or national basis. Also there are two aspects of laboratory assistance that might be kept apart. One is the routine characterization to aid placement of soils in proper classification categories. The other is research or investigations, where laboratory personnel may be usefully involved to work on the problem.

Non-farm interpretations are becoming more and more in demand. This is especially true when uses are related to waste disposal, soil and water pollution by misuse of pesticides and fertilizers, pipe corrosion, and Co those uses related to soil stability when used for foundations for structures. We must have more research data on the items listed above if we are going to meet our responsibilities in soil interpretations in the years ahead. Our laboratory people should have adequate financial support so they can help with these interpretations. It is important that they be knowledgeable about the research under way in these fields and be prepared to help soil scientists apply the results. In addition, Agricultural Experiment stations should be encouraged to give more attention to laboratory work that will help to make and to improve "on-farm interpretations.

It Is Recommended

1. That we strive to get more financial support for our laboratory work so that i" addition to their present program the soil survey laboratories can accelerate their participation in research to determine soil characteristics needed to predict pollutant behavior in soils and the Agricultural Experiment Stations be encouraged to give a higher priority to studies that will help to make and to improve "on-farm interpretations.

2. The National Committee concurs in that the Director for Soil Survey Investigations provide leadership in a national project for characterizing organic soil material and tidal marsh.

3. That the state soil survey Plan of Operations show special soil studies or investigations projected over a three-year period and show soils to be characterized, classification, target date and who will do the work (Soil Survey Laboratories or Experiment Station Laboratories).

4. The Committee be continued.

Committee Members

James V. Drew	*Robert B. Grossman	*E. J. Pedersen
D. P. Franzmeier	"A. A. Klingebiel	*J.M. Williams, Chairman

*Members present at Charleston, South Carolina January 25-28, 1971.

Notes on discussion by the Conference following presentation of committee report.

Kellogg: It is difficult to get additional federal funds for laboratory work. Hopeful that the Experiment Stations provide more research data for overcoming soil limitations.

Bartelli: Rather than put emphasis on benchmark reports, lets put the data on tape and turn it out as "printouts" of the data.

Williams: The committee report does place emphasis on using ADP Lo get out benchmark reports. Reports of the future will not he so much written as assembled.

Hockensmith: Some state funds are going to research (Pa., etc.).

Wilding: Ohio has a PhD working on engineering properties of sails. We need better communications among engineers and soil scientists.

Kellogg: There is an urgent need for soil scientists and engineers to understand each ocher and work together to overcome limitations.

Orvedal: Asked if recommendation 1 (Soil Survey Laboratory Investigations) implied that SCS laboratories will be restricted to characterization.

Williams: This was not the intent and the recommendation will be rewritten to emphasize interpretations as well as characterizations.

Grossman: Recommendation 2 (Soil Survey Investigations) was broadened from the Northeast Region report to include organic soil material. It is important that we obtain data about organic soil material and tidal marsh for inclusion in the Soil Survey Manual.

Kellogg: We need to determine what is the critical data and concentrate on that. We can't run all kinds of laboratory data.

Klingebiel: We have a need for more research on non-farm interpretations.

Cline: Most research in engineering is through grants for specific studies. We must work closely with engineers Co find funds available from HEW. MIT and others are the leaders in this area. It is urgent that we establish a contact with these people.

The report was accepted by the Conference.

Attachment 1

Benchmark Soil Characterization Inventory

Benchmark Soil Series	Family Placement	Complete characterization data available a/: Soil Sur. Laboratory	Experiment Station	Other (specify)	Partial characterization data available: Soil Sur. Laboratory	Experiment Station	Other	Data needed to complete char.	Type location characterized yes or no	Suggested sampling (year)
		(No. of pedons)				(No. of pedons)		(see code)		

a/ Complete characterization data includes P.S.D.A., pH, organic carbon, linear extensibility, 15 and 1/3 bar water, cation exchange data, mineralogy, and all data needed to classify soils down to family level.

Analysis code	Analysis code	Analysis code	Analysis code
1. P.S.D.A.	6. 1/3 bar	11. Min. clay	16. Other specify
2. pH	7. Ext. Al (KCl)	12. Min. sand	17. Other specify
3. Organic carbon	8. Ext. Fe C-D	13. Thin sections	18. Other specify
4. Linear extensibility	9. Ext. cations	14. Spodic horizon	19. Other specify
5. 15 bar water	10. CEC(NH_4) pH 7	15. Other specify	20. Other specify

REPORT OF COMMITTEE 2 -
CLASSES AND PHASES OF STONINESS AND ROCKINESS

The initial work of this committee involved a field study with a primary objective to test the current Manual class limits for stoniness and rockiness and their significance to "se and management. Mr. Charles Breeding, Associate Professor, Thompson School of Applied Science, conducted this study during the summer of 1970.1/ Study areas were located throughout New Hampshire. An integral part of this study is the interviews conducted with land developers, woodland managers, recreation area managers, and others to obtain their views on the "se limitations imposed by various stoniness end rockiness conditions. A secondary objective of the study was to develop field techniques for quick and accurate estimates of stoniness and rockiness conditions. A copy of Mr. Breeding's report is included as an appendix to this committee report.

The current work of revising the Sail Survey Manual has given additional emphasis to the work of this committee. Specifications for several items considered by this committee will also have to be written into the manuscript for the revised Manual. The committee proposals, outlined below, are recommended to this conference for adoption as proposed or with modification as needed.

There were no regional committee reports available for consideration by this committee.

Recommendations

A. Proposed Stoniness Classes and Suggested Phase Names

The need for flexibility in a system proposing classes for stoniness became apparent early in committee work. The needs of different regions vary widely. The northeast region appears to need a more sophisticated system than other regions. Generally, this region has given higher priority to the study and testing of classes of stoniness than other regions.

The committee proposes that class limits be expressed in percent of surface area covered and that size and spacing be used as determining criteria. Tables 1 and la present this relation. ship.

Seven classes of stoniness are proposed. This represents one more additional class than provided in the current Manual. The existing Class 4 (15 to 90 percent of surface area covered) would be divided into two classes as follows: (a) 15 to 50 percent and (b) 50 to 90 percent. Our experience to dare indicates that the naming and classifying of soils becomes very difficult when surface stoniness conditions exceed 50 percent. The 1970 field study also supports the need for a separation at 50 percent. Mr. Breeding found that when surface stone cover exceeded 50 percent, the limitations imposed on land "se were so severe that special planning measures, the use of special equipment, and a much greater cost resulted.

Table 1 provides committee proposals for classes of stoniness determining criteria and Phase names. Table la has been developed for the metric ""its of measurement. A Class 0 designation has not been used in the proposed system co avoid ambiguity in work with ADP systems.

The committee recommends that agencies conducting soil surveys test the two methods proposed by Mr. Breeding for field determination of surface stoniness, Separate methods are proposed for conditions of sparsely scattered stones.

B. Proposed Rockiness Classes and Suggested Phase Names

The committee proposes that class limits be expressed in percent of area with rock outcrop exposure.

Six classes of rockiness are proposed. This represents the same number of classes provided in the current Manuel. Changes in class limits are proposed for only two classes. The upper limit for Class 1 and lower limit for Class 2 are proposed at 3 percent.

1/ Mr. Breeding is employed by the New Hampshire SCS State Office during the summer months to assist in studies such as this one.

Table 2 provides committee proposals for classes of rockiness and phase names. A Class 0 designation has not bee" used to avoid ambiguity in work with ADP systems.

Naming of Mapping Units that Involve Rock Outcrop

Considerable effort was devoted to the coordination of committee recommendations with the conventions for naming of mapping units (complexes and associations) as outlined in Soils Memorandum-66. Most discussion focused on the following sentence on page 15 of this memorandum under 2.- Complexes:

"No single component that contrasts sharply with the extensive component soils is to exceed 10 percent of the whole, etc."

The committee recognizes that the need for rockiness phases in several regions has bee" minimized by the 10 percent limit. Areas that have more than 10 percent rock outcrop exposure are handled as a complex (association) of one or more taxonomic units and rock outcrop or in a ruptic subgroup. I" this situation, rockiness phases would be needed only for Classes 1 and 2.

The committee suggests that Class 6 he designated Rock outcrop.

****

This cowittee has attempted to propose systems with adequate flexibility to accommodate the needs of different regions. However, there is still a need for further testing of stoniness and rockiness class limits relative to their significance to use and management. In addition, field personnel continue to need quick and accurate methods for estimating stoniness and rockiness conditions. The committee recommends that this report be referred to agencies conducting soil surveys for further testing end evaluation.

Membership Committee

W. E. McKinzie	S. Rieger
C. A. Mogen	B. G. Watson
0. c. Olson, Secretary	J. R. Coover

S.A.L. Pilgrim, Chairman

Attachment.:
1970 Field Study Report
Notes on Discussion of the Report by the Conference

Notes on Discussion of the Report by the Conference

Kellogg : I suggest you round off the metric figures in your tables just as you have the others. As they stand, the metric figures give a false sense of accuracy.

Cline : I ask that you provide me with the definitions of the phase classes in terms of their meaning to management. We need this for the manual revision in addition to the definitions of the class limits in percentage figures.

Pilgrim : This can be provided.

Simonson: The concept definition of many soil series does not include a rock component. Rather. we are dealing with an association of a classifiable soil and rock. We prefer this to phasing the soil series.

Orvedal : I would like to have your report more clearly differentiate stone and boulder sizes.

Pilgrim : Separate tables are included in the report to provide diameter sizes in both English and metric units.

Kellogg : Are these classes satisfactory to the foresters'!

Olson : On National Forest lands, we are mainly concerned with characterizing the mapping units in terms of ranges, as well as modal stoniness characteristics. It's a matter of describing stoniness as it occurs. The classes and class names are primarily useful for narrative and discussion purposes.

The report was accepted by the Conference.

Proposed Classes of Stoniness, Determining Criteria and Phase Names

Table 1

Stoniness Class	% of Surface	Diameter of Stones and Boulders in Feet 0.83	1.0	1.5	2.0	3.0	Il.0	Suggested Phase Names 1/ Narrow Phase	Broad Phase
		Spacing in feet							
1	Less than 0.01	82+	99+	148+	198+	297+	396+	Non-stony	
2	0.01-0.1	25-82	30-99	46-148	61-198	92-297	122-396	Slightly stony or bouldery	Stony or bouldery
3	0.1-3	4-25	5-30	7-46	9-61	14-92	19-122	Moderately stony or boulder-y	Stony or bouldery
4	3-15	1.34	1.6-5	2.4-7	3.2-9	4.7-14	6-19	Very stony or bouldery	Stony or bouldery
5	15-50	.3-1.3	A-1.6	.6-2.4	.8-3.2	1.2-4.7	1.7-6	Extremely stony or bouldery	Stony or bouldery
6	50-90	.04-.3	.05-.4	.08-.6	.11-.8	.16-1.2	.22-1.7	Exceedingly stony or bouldery	Stony or bouldery
7	90+	(less than) .04	.05	.08	.11	.16	.22	Rubble land	Rubble land

1/ Bouldery name to be used where more than 50 percent is of boulder size

Proposed Classes of Stoniness, Determining Criteria and Phase Names

Table 1a

Stoniness Class	% of Surface	Diameter of Stones and Boulders in Meters: 0.25	0.30	0.46	0.61	0.91	1.22	Suggested Phase Names 1/: Narrow Phase	Broad Phase
		Spacing in meters							
1	Less than 0.01	25+	30+	45+	60+	91+	121+	Nan-stony	
2	0.01-0.1	7.6-25	9.1-30	14-45	18.6-60	28-91	37.2-121	Slightly stony or bouldery	Stony or bouldery
3	0.1-3	1.2-7.6	1.5-9.1	2.1-u	2.7-18.6	4.3-28	5.8-37.2	Moderately stony or bouldery	Stony or bouldery
4	3-15	.40-1.2	.49-1.5	.73-2.1	.98-2.7	1.4-4.3	1.8-5.8	Very stony or bouldery	Stony or bouldery
5	15-50	.09-.40	.12-.49	.18-.73	.24-.98	.37-1.4	.52-1.8	Extremely stony or bouldery	Stony or bouldery
6	50-90	.01-.09	.02-.12	.02-.18	.03-.24	.05-.37	.07-.52	Exceedingly stony or bouldery	Stony or bouldery
7	90+	(less than .01)	.02	.02	.03	.05	.07	Rubble land	Rubble land

1/ Bouldery name to be used where more than 50 percent is of boulder size.

Proposed Classes of Rockiness and Names

Table 2

Rockiness Class	Percent of Area with Rock Outcrop Exposure	Suggested Phase Names (Classes 1, 2 and 3)
1	< 3	Non-rocky
2	3-10	Rocky
3	lo-25	Very rocky
4	25-50	Soil-Rock outcrop complex
5	SO-90	Rock outcrop-Soil complex
6	More than 90	Rock outcrop

STUDY OF STONINESS AND ROCKINESS CLASSES
JULY-AUGUST 1970

Charles H. Breeding*

The purpose of this study was three-fold; first, to examine the effect of varying degrees of stoniness and rockiness on selected land uses; second, to develop field techniques for quick and accurate determination of classes and phases of stoniness or rockiness; and third, to determine the relevancy of present stoniness/rockiness classes to nonagricultural uses.

For five weeks during July and August, 1970, in the company of the local soil scientist, I made on-site investigations of the effect of degree of stoniness on land used for recreation, woodland operations. and community development.

The sizes of individual stones, boulders. or rock outcrops and the distances between them were measured, and the percent Of land area covered was calculated from these data. We talked with land developers, woodland operators and recreation area managers to find their views on stony land and limitations it might impose on their particular use of land.

I documented these studies with color slides and black and white photos of specific problem areas and of various stoniness and rockiness classes.

At the outset, certain types of uses were excluded from this study. While undoubtedly a recreational use--athletic fields, playgrounds--and similar intensive use areas obviously tolerate no surface stones or rocks, data on stone removal for cultivated crops are obtainable and apply to these situations. Similarly. urban housing developments have comparable qualifications for building sites. (In many of these uses, the primary limit of degree of slope must be met, irrespective of stoniness,)

Specifically, the areas studied included fourteen campsites and picnic spots, three ski slopes, twelve vacation/retirement home developments, five nature study sites, and fifteen logging operations. Also used were various hayfields, pastures and woodlots, selected for the degree of stoniness and rockiness they typified. The areas studies were scattered widely throughout seven of the state's ten counties.

FINDINGS: Initially, one basic opinion must be stated: no premise founded on percent of surface area covered alone is valid; the average size of stones or rock outcrops must be considered jointly with area. For ease of discussion, findings will be listed by category.

I. Limitations Imposed by Stoniness/Rockiness on Selected land Uses.

A. Campsites and Picnic Spots: Other considerations--sewage disposal and near-level plots for trailers--were more restrictive in choice of land for campsites than surface stones.

Germ-ally, an area coverage of more than twenty percent with size of less than five feet made site preparation costly. The presence of boulders greater than seven feet called for road relocation and required greater care in laying out individual campsites. Rock outcrop presented no limitation so long as it conformed to the land surface.

The range in size of picnic areas was large; from single roadside tables to those sites with twenty or more units. So long as there was sufficient space for parking and for placing picnic tables, stones and rock were no hindrance; in fact, they heightened the appeal of a site to picnickers.

B. Ski Slopes: In all areas observed, boulders up to six to seven feet in diameter had been bulldozed to the side of ski trails.

Within these size classes, surface coverages of up to fifty percent (based on adjoining undisturbed land) were cleared for trails. Boulders eight feet in diameter and larger were too large to move readily and the trails were rerouted around them. Several areas with greater than fifty percent surface covered by boulders of various sizes were avoided in laying out the trails.

---

* Soil Scientist, USDA-Soil Conservation Service, Durham, New Hampshire

Ledges and rock outcrops present a different problem. In late winter and early spring, ice forms on exposed bedrock and makes skiing hazardous. Several spots were photographed, where the ledge was drilled and blasted to permit water percolation and facilitate revegetation, with limited success. Other bare spots were mulched heavily to a depth of at least one foot, thereby greatly limiting ice formation. Sections of some ski trails were fifty percent open ledge for two hundred feet or more.

Ledges whose surface conformed to the adjoining land proved no real obstacle to trail development, within a limit of fifty percent surface coverage; but bench or step-like ledges were an immediate hazard to trail layout and were avoided. The presence Of over twenty percent Of this type ledgeseverely limited development.

C. Nature Study Sites: Sites in this class included the stoniest one studied, the entire surface area being a jumble of boulders. The moist atmosphere from a stream, often subterranean, flowing through the middle of this gorge and the limited exposure to sunlight, favored a profuse growth of ferns, mosses, lichen and other flora not commonly found.

In each instance, stoniness or rockiness added an exotic or wild quality and increased its attractiveness for people.

D. Vacation/Retirement Home Developments: Stoniness or rockiness did not limit the use of land for vacation or retirement hares, either within developmentsor without.

The extreme example was a single lot of two-thirds of an acre, seventy percent of the surface open granite ledge. The lot itself cost $18,500 and site preparation--blasting a hole for the foundation and extending the area for the leach beds--cost a" additional $10,000. Other lots were seen which approached this in cost of site preparation.

Surface stones or boulders usually added to the sale value of a lot, giving the lot a unique and picturesque character, with interesting architectural and landscaping possibilities. Several lots had fifty percent or more of the surface covered with boulders up to twenty feet in diameter. In fact, boulders are preferred to stones, and large boulders over mall.

Slope of the land must inevitably be considered in conjunction with stoniness. Most developers, for this type of buyer, prefer to have a minimum slope of eight percent; this gives every lot a view. There is no upper limit other than that which percludes road building.

The developers' chief problem is areas of ledge and/or shallow soil which either require mad relocation, or drilling and blasting for roads and water lines. This condition has not stopped development; it has added to the cost. The extremely stony or rocky spots were sections of larger areas. In no instance did surface coverage of stones. boulders, or rock outcrop exceed thirty percent for the entire development.

E. Woodland Operations: Tree growth was found on open ledge and tree cover on land with ninety percent of the surface covered by stones or boulders. Site quality was effected by quantity of stone and shallowness to bedrock, but our principal interest was with the effect of stones and ledge on logging operations.

Woodlots of up to seventy percent of the surface covered with boulders had been logged. The combination of size of stones/boulders and percent coverage determined the feasibility and type of logging operation.

Felling of timber was not limited; removal of logs from the area--skidding--and the establishment of roads for logging trucks and for skidding were limited by size and distribution of boulders. stones present no limit to logging operations. For mechanical skidding, the boulders must be far enough apart for the skidder to pass between readily; be small enough to ride over; or be so closely spaced and eve" in height that the skidder can run over them as on a road of giant cobbles.

Several lots were observed where skidding by a team of horses was the only possible method; the boulders were too large and too closely spaced for machine operation. Conversely, there were two woodlots where horses could not work safely due to the close spacing and size of boulders, whereas, a skidder rode atop them rather easily.

Skid roads have the same limitations as skidding, plus an additional one, in that twisting in the road to avoid large boulders or protruding rock outcrop limits the length of log being skid&d. Excessive twisting damages logs being skid&d and standing trees, and increasingly so, as tree length logs are brought out.

Woods roads for truck hauling of logs or bolts are more demanding of site. Surface stones and boulders, except the largest, are readily bulldozed aside and jutting ledge can be avoided. Slope and drainage present greater limitations to woods road construction than stoniness alone.

It is virtually impossible to set any uniform standards limiting woodland operations. The size of stones and the percent of surface covered, the method of logging, and the economic value of the timber crop must be considered in determining limitations on any given woodlot. From my observations, if valuable timber is present, stoniness or rockiness will not prevent its harvest.

II. Field Determination of Stoniness/Rockiness Class

It is the experience of many that field determination of stoniness/rockiness classes is liable to the usual caprices of subjective judgment. Estimating or eyeballing is likeliest of error.

Several methods involving measurement have been suggested for more accurate placement. Measuring the distance between stones and the average diameter of stones and referring to a table is recommended by the Soil Survey Manual and by the Committee on Classes and Phases of Stoniness and Rockiness of the National Technical Work-Planning Conference of the Cooperative Soil Survey. This method works well in the lower percentages of surface area covered but is not adapted to higher percentages or to rockiness.

I have tried several in the field and have settled on three--two for stoniness and one for rockiness--as being both quick and accurate. I have enclosed tables giving criteria for the present Soil Survey Manual classes and for proposed New Hampshire classes.

First, for sparsely scattered stones or boulders the average distance between stones, edge to edge, and the average diameter (assuming square stones) can be readily computed. These measurements can be compared with Table #1 and will fall within the range of measurements for a particular class.

Should a person want the exact percent of surface area covered, he can calculate it from the formula $A = (D/D+E)^2 \times 100$, where A = percent of area covered, D = average diameter of stones, and E = distance between stones; all measurements in feet, For example, if the average diameter of boulders is found to be 30 inches and the average distance between them is 8 feet, then $A = (2.5/2.5+8)^2 \times 100$ or 5.7%.

Second, where stones are moderately or thickly scattered, it is quicker and just as precise to compute the average diameter and then count the number of stones within a given area; reference to Table 1 will give the stoniness class. In the table various areas are used according to size and density of distribution.

Again, should the precise percent of surface area covered be desired, it can be calculated from the formula $A = NxD^2/As \times 100$, where A = percent of surface area covered, N = number of stones in the sample plot and As = area of sample plot; all measurements in feet or square feet. For example, if a plot 40 ft. x 40 ft. were measured and it contained 7 boulders with an average diameter of 3.5 feet, then $A = 7x3.5^2/1600 \times 100$ or 5.36%.

Third, for use with ledge or rock outcrop, lay cut three 100 ft. transects randomly. Along these transects, measure the lineal feet of rock traversed. Obtain the average of the three and refer this figure to Table 2 for appropriate rockiness class.

If the exact percentage is needed, calculate by the following formula, $A=L^2/100$, where A = percent of surface area covered and L = lineal feet of rock per hundred feet of transect, For example, if the average lineal feet of rock traversed in three one-hundred foot transects were 27.5, then $A = 27.5^2/100$ or 7.56%.

III. Evaluation of Present Classes of Stoniness and Rockiness

For the land uses studied, the Soil Survey Manual classes are too fine on the low end and not fine enough where percent of surface area covered exceeds three. It must be re-emphasized that area alone is a questionable basis for use decisims. Two sites, one with six-foot boulders fifteen feet apart edge to edge and a second with me-foot stones two and a half feet apart, cover eight percent of the surface area but present quite different problems for use. In the first, machine mowing is possible; in the second, it is out of the question.

However, as a guide, the class plus the size designation, stony or bouldery, should suffice for soil mapping with the reservation that on-site investigation may be necessary; this is no departure from our handling of other soil properties in interpretations. It would be helpful and meaningful to divide the bouldery phases into large and small with a break point at six feet. Several cases were observed where boulders over six feet were found too costly or difficult to me, whereas, those six feet and under could be moved.

The fifteen percent boundary seems a valid one in dividing land suitable for improved pasture from other less intensive uses. Several such areas were documented. Also, the three percent boundary appears justified to spearate the arable from non-arable. Perhaps the division could be placed elsewhere but seem workable at this pint. One area was photographed where large boulders, seven feet in diameter at an average thirty-six-foot spacing or 2.6 percent coverage did not limit haying.

The fifty percent division is quite necessary. While there were several instances of woodland operations and house building on sites with greater than fifty percent surface coverage, each such instance required special measures, replanning, specialized equipmnt, or a much greater outlay of money.

I believe this fifty percent boundary serves a valid purpose in alerting landowners and planners to a condition of stoniness or rockiness so severe that a long second look is demanded. lhe fifteen to fifty percent class presents problems but not the same kind or to the same degree as the over fifty percent.

Finally, some comments on rockiness are in order. Much depends on the type of bedrock and the manner of its deposition and exposure. If the ledge comprises rock strata on edge, the soil between may be deep and have great use. With such rock outcrop Class IV is justified. However, where the outcrop is broad, flat expanses of granite with thin patches of shallow soil between classes IV and V could be reasonably combined. To achieve fifty percent surface coverage, one must cover 70.71 feet of ledge in a one-hundred-foot transect; to achieve ninety percent, you have to cover 94.87 feet. The distinction is academic and appears justified only if one wishes to show sheer cliff face and here slope is the factor. Further, I question the necessity of separate tables of classes for stoniness and rockiness. In the field, I could find no justification for this separation.

Note: The documentation of this study includes one hundred thirty seven edited color slides, and one hundred six 4 x 5 black and white prints.

TABLE OF STONINESS CLASSES

Distance between stones in feet and density of distribution according to percent of area covered and the diameter of stones

Average diameter of stones in feet (assuming square stones)

Percent of Surface Area Covered	0.83	1.0	1.5	2.0	3.0	4.0	5.0	7.0	10.0
0.01%									
Distance edge to edge	82.2	99	148.5	198	297	396	495	593	990
Density of distribution	$3/20,000ft^2$	$1/10,000ft^2$	$1/20,000ft^2$	$1/40,000ft^2$	$1/90,000ft^2$	$1/160,000ft^2$	$1/250,000ft^2$	$1/490,000ft^2$	$1/100,000ft^2$
0.1%									
Distance edge to edge	25.4	30.6	46.0	61.3	91.9	122.5	153.0	214	306
Density of distribution	$3/2000ft^2$	$1/1000ft^2$	$9/20,000ft^2$	$5/20,000ft^2$	$1/10,000ft^2$	$6/100,000ft^2$	$4/100,000ft^2$	$2/100,000ft^2$	$1/100,000ft^2$
3%									
Distance edge to edge	4.0	4.8	7.2	9.5	14.3	19.1	23.9	33.4	47.7
Density of distribution	$44/1000ft^2$	$30/1000ft^2$	$13/1000ft^2$	$15/2000ft^2$	$10/3000ft^2$	$2/1000ft^2$	$12/10,000ft^2$	$6/10,000ft^2$	$3/10,000ft^2$
15%									
Distance edge to edge	1.3	1.5	2.4	3.2	11.7			11.1	15.8
Density of distribution	$22/100ft^2$	$15/100ft^2$	$13/200ft^2$	$4/100ft^2$	$5/300ft^2$	$1/100ft^2$	$6/1000ft^2$	$3/1000ft^2$	$3/2000ft^2$
50%									
Distance edge to edge	0.34	0.4	0.6	0.8	1.24			2.9	4.1
Density of distribution	$18/25ft^2$	$25/50ft^2$	$11/50ft^2$	$3/25ft^2$	$11/200ft^2$	$3/100ft^2$	$2/100ft^2$	$1/100ft^2$	$1/200ft^2$
90%									
Distance edge to edge	0.04	0.05	0.08	0.11	0.16		0.27	0.38	0.54
Density of distribution	$33/25ft^2$	$23/25ft^2$	$10/25ft^2$	$11/50ft^2$	$10/100ft^2$	$6/100ft^2$	$4/100ft^2$	$2/100ft^2$	$1/100ft^2$

Table #1

Calculations by C.H.J. Breeding 8/26/70

Table for determining rockiness class based on
measured feet of rock traversed in 100 lineal ft. transect

Feet of Rock per 100 feet	Percent of Area Covered	Soil Survey Manual Class	Proposed N.H. Class
< 3.16	< 0.1		1
< 14.14	< 2	0	
3.16-17.32	0.1-3		2
14.14-31.62	2-10	1	
17.32-38.73	3-15		3
31.62-50.00	10-25	2	
38.73-70.71	15-50		4
50.00-70.71	25-50	3	
70.71-94.87	50-90	4	5
> 94.87	> 90	5	6

Calculations by C.H.J. Breeding 8/26/70

Table #2

National Technical Work-Planning Conference of the Cooperative
Soil Survey - Charleston, South Carolina, January 25-28, 1971

Committee 3. Standards for Descriptions of Soils

This committee was concerned with standards and conventions for the description of soils in the field. It8 objectives were (1) to identify soil properties or features for which it seems feasible now to improve the standards or conventions provided in the current Soil Survey Manual or to establish standards for the description of soil features that are treated briefly or not at all in the Manual, and (2) present proposals for revised or new standards for the description of such properties or features. It was hoped that the committee could screen existing proposals, probably modifying them to same extent, or make new ones that could be adopted with a minimum of testing in the field.

The reports of the 1970 Northeast Regional Committee on Criteria for Soil Series and Phase,,, the 1970 Western Regional Committee on Soil Structure and Fabric, and the 1969 National C-it-tee on Criteria for Soil Series and Phases contained pertinent discussions and recommendations and these were considered during the deliberations of Committee 3.

Most of the work of the committee was handled by correspondence. Following an initial exchange of letters, eight subcommittees were appointed the latter part of September 1970. The subcommittees were to make recommendations concerning particular soil properties or features commonly included in descriptions of soils in the field. Each member was assigned to three subcommittees. During late November and December subcommittee chairmen sent reports of the work of their subcommittees to the whole membership of Committee 3 for review and comment. The report to the conference was based on the reports of the subcommittees plus subsequent correspondence and discussions.

The subjects and members of the subcommittees were as follows:

A. Land form, relief, end slope

J. w. Hawley - Chairman	R. I. Dideriksen	D. W. Swanson
R. B. Daniels	s. Rieger	M. Stout, Jr.

B. Parent materials

B. L. Matzek - Chairman	L. H. Gile	D. W. Swanson
J. E. Brown	J. w. Hawley	

C. Soil horizons, identification and nomenclature

D. F. Slusher - Chairman	K. W. Flach	W. D. Nettleton	M. stout, Jr.
J. A. DeMent	L. H. Gile	0. W. Rice	
R. I. Dideriksen	J. E. McClelland	R. w. Simonson	

D. Soil color and mottling

A. J. Cline - Chairman	G. s. Holmgren	0. W. Rice	D. F. Slusher
J. A. DeMent	A. 0. Ness	s. Rieger	

E. Soil texture and coarse fragments

R. C. Carter - Chairman	J. w. Hawley	w. D. Nettleton
A. J. Cline	B. L. Matzek	s. Rieger
K. W. Flach	A. 0. Ness	R. w. Simonson

F. Soil structure and consistence

R. B. Daniels - Chairman	R. B. Grossman	J. E. McClelland	M. stout, Jr.
R. C. Carter	G. S. Holmgren	W. D. Nettleton	
L. H. Gile	B. L. Matzek	'D. F. Slusher	

G. Roots, pores, concretions, nodules, accretions

J. A. DeMent - Chairman, R. C. Carter, A. O. Ness, D. W. Swanson, J. E. Brown, G. S. Holmgren, R. W. Simonson

H. Clay films and skeletans

J. E. Brown - Chairman, R. B. Daniels, K. W. Flach, O. W. Rice, A. J. Cline, R. I. Dideriksen, J. E. McClelland

The material that was prepared by Committee 3 end distributed to members of the conference in Charleston for discussion was more voluminous than would be practical to include here. The reports of three subcommittees were not discussed by the conference because of insufficient time and they are not included in this report. They are: A. Landform, relief, end slope; B. Parent materiels; and D. Soil color and mottling. Reports of those subcommittees were distributed to each participant in the conference.

The topics included in this report are presented in the order in which they are listed above.

C. Soil Horizons, Identification end Nomenclature

Appreciable modifications Of the current conventions for horizon designationa are proposed. The main purpose of the major changes is to provide a more orderly system. The proposed conventions are simpler than the current ones because special cases and exceptions to rules are fewer. The proposed system should be easier to learn and to apply consistently.

Proposed changes are presented approximately in the order in which the topics are discussed in the 1962 Supplement to the &Survey Manual, pages 173-188.

Main features Of a proposed system Of identification and nomenclature of soil horizons

1. Major assumptions. Assumptions on which the proposed horizon designations are based are intended to be similar to the ones underlying the 1962 Supplement. They are es follows: We should continue the present system of ABC nomenclature, extended to include 0 and E es master horizons. The horizon symbols are genetic designations. Their main purposes are to show the relationships among horizons within a profile and to allow useful comparisons of horizons among different soils. The horizon designations do not substitute for clear end complete descriptions of each horizon. The horizon designations should not denote diagnostic horizons or features of the soil classification system; but the horizon designations must be compatible with the diagnostic horizons end features. The former are defined largely in qualitative genetic terms, the latter largely in quantitative terms of morphology and composition.

2. Conventions governing "se of symbols. In order to provide a more orderly system of horizon symbols the connotative arabic numbers in the current system should be eliminated. The following changes from current conventions would accomplish this and would simplify the system.

   a. Substitute capital letter symbol E for A2.

   b. Show transitional horizons by combinations of capital letter symbols; for example, BC instead of B3.

   c. Lower case letters, when pert of a symbol, will be placed immediately following the capital letters instead of being used as suffixes as in the current system. This will contribute toward a more orderly system of symbols and to avoidance of confusion between the current system of symbols and the proposed one. NO more than two lower case letter symbols will be used in a horizon symbol.

   d. Indicate vertical subdivisions within an otherwise undifferentiated horizon by arabic numeral suffixes. The subdivisions set apart by this device are numbered consecutively starting with number 1 et the top of each horizon that is so subdivided. The arabic numbers are used only if they are required to form unique symbols for each horizon of a profile.

   e. If the master horizons O, A, or B are subdivided in a horizon sequence, a lower case letter symbol immediately following the capital letter is required for each subhorizon symbol. Arabic numbers may not immediately follow the capital letter in symbols in which 0, A, or B are used singly. Arabic numbers may immediately follow E and C end capital letter combinations that denote transitional horizons. This convention is required to avoid confusion between the proposed use of arabic number suffixes for vertical subdivision only and the current connotative numbers in the symbols 01, 02, Al, A2, A3, Bl, B2, and B3.

f. Arabic numerals are prefixed to the master horizon designations (A, E, B, C, R) to indicate lithologic diecontinuities. The reasons for this change are to shorten the symbols and to facilitate data processing by computers.

The proposed changes are illustrated by the following pairs of horizon sequences.

Pair 1 (Hapludult)		Pair 2 (Typic Hapludoll)		Pair 3 (Typic Dystrochrept)	
Ap	Ap	All	Ahl	Ap	Ap
AZ	E	Al2	Ah2	B21	Bsl
B2lt	Btl	B2	B	B22	Bs2
B22t	Bt2	B3	BC	B3	BC
B3	BC	C	C	C	C
C	C			R	R

Pair 4 (Fragiudalf)		Pair 5 (Entic Durorthid)		Pair 6 (Entic Haplaquod)	
01	Oi	Al	Ah	Ap	Ap
Al	Ah	B2	B	A21g	Egl
A2	E	Clsi	Csi	A22g	Eg2
Bl	BE	C2sim	Csim	Bl	BE
B21	Btl	IIA&Bsib	2A&Bsib	B21	Bhl
B22	Bt2	IIB2ltcab	2Btbl	B22	Bh2
B&A	B&E	IIB22tcab	2Btb2	B23	Bh3
B'21	B'tl	IIIB3tcscab	3BCcsb	B24	Bh4
B'22	B't2	IIIClsicam	3Csim	Cg	Cg
B'xl	BCxl	IIIC2sica	3Csical		
IIB'x2	2BCx2	IIIC3sica	3Csica2		
IIC	2c	IVC4sica	4Csica		

3. **Lithologic discontinuity.** It is proposed that the discussion beginning at the top of page 176 in the 1962 Supplement be modified along the following lines.

A lithologic discontinuity is a significant change in composition, usually a difference in one or more of particle size distribution, mineralogy, or color, that indicates a difference in the material from which the horizons have formed. One purpose of identifying lithologic discontinuities is to aid in distinguishing those differences between horizons that are the result of pedogenesis end those that are geologic. Another is to identify differences or similarities between presumed parent materials of genetic horizons and c or R or between C end R. General statements of the degree difference in properties that constitute a significant discontinuity are of limited usefulness. For example, a small increase in percent fine send et the contact between an overlying loess and en underlying glacial till or an underlying coastal plain sediment would warrant recognition of a lithologic discontinuity in most situations. But a similar change in sand content within alluvium or coastal plain sediments rarely would be significant. As a general guide, therefore, symbols to mark a lithologic discontinuity should be used when that would contribute to the reader's understanding of the relationshipa among the horizons.

In descriptions of soils lacking developed horizons other than an A horizon and formed in stratified sediments arabic numbers to mark lithologic discontinuities should be used sparingly. In most such instances the differences in material8 should be strongly contrasting in texture or mineral composition end the layer thicker than about 10 inches in order to warrant identification of the discontinuity. Differences in texture that would support classification of a pedon in a contrasting texture family ordinarily would warrant a lithologic discontinuity, but a layer only several inches thick would not, even though it was strongly contrasting.

4. **Sequum.** It is proposed that item 6 on page 176 of the 1962 Supplement be modified along the following lines.

AB horizon together with one or more of its overlying O, A, or E horizons, if one or more of these are present, is celled a sequum. Any one of the several kinds of B horizon, together with its overlying 0, A, or E horizons if present, constitutes a sequum. If more then one sequum is present in vertical sequence, horizon designationa of the lower sequum may be given a prime accent if the horizon designations of the two sequa are not otherwise different. In the two examples that follow, prime accents are needed in one horizon sequence but are not needed in the other.

Ah	Ap
E	Bt1
Bt	Bt2
E'	E
B't	Bx

Master horizons end layers.

Organic Horizons

It is proposed that the distinctions between organic material end mineral material as defined in the Soil Taxonomy be adopted es the main definitions of the distinction between organic horizons end mineral horizons. We see no reasonable alternative if the horizon designations are to be compatible with the taxonomy. The committee also recommends thet the symbols Oa, Oe, end Oi be adopted for organic horizons or layers of both mineral. soil8 end organic soils. (See the discussion at the end of this section.) The concepts of Oa, Oe, end Oi would parallel the concepts of sapric, hemic, end fibric materials, respectively, which follows the recommendation of the 1969 National Technical Work-Planning Conference. Definitions need to be prepared. It was not determined whether the definitions should follow closely the definitions in the soil classification system or whether generalized definitions abstracted from the letter would be suitable. The definitions below have not been reviewed by Committee 3 but they can be treated as proposals for discussion.

0 - Organic horizons consist of soil materiels dominated by fresh or pertly decomposed organic materials that either: 1. are saturated with water for prolonged periods, or are artificially drained, end have (a) 18 percent or more organic carbon if the mineral fraction is 50 percent or more clay, or (b) 12 percent or more organic carbon if the mineral fraction he8 no clay, or (c) proportional intermediate organic contents if the clay fraction is intermediate, or 2. are never saturated with water for more than a few days and have 20 percent or more organic carbon.

Organic horizons may be present es the surface horizon of mineral soils or et any depth beneath the surface in buried soils but they have been formed from accumulations of organic litter derived from plants end animals and deposited on the surface. They may be very thin surficial horizons of mineral soils or many feet thick in organic soils. The 0 horizons do not include soil horizons formed by illuviation of organic material in miners1 soils.

Because thin organic horizons et the surface may be rapidly altered in thickness or be destroyed by fire or the activities of men or other animals, the depth limits of organic horizons that are et the surface of mineral soils are always measured upward from the top of the underlying mineral horizon. Depth limits of organic horizons at the surface of organic soils are measured downward from the surface of the soil. Three major subdivisions of 0 horizon are recognized.

Oi - Organic horizons in which essentially the original form of most vegetative matter is visible to the naked eye.

These are the least decomposed of the organic horizons. They contain large amounts of fiber which is well preserved and readily identifiable as to botanical origin. The former O1 horizons are included.

Oa - These are the most highly decomposed of the organic materials. They have the least amount of plant fiber and the highest bulk density values. The remains of parts of plants end animals commonly can be Identified with magnification but evident plant fiber makes up a small proportion of the soil volume. Many of the former O2 horizons are included.

Oe - These are intermediate in composition between the less decomposed Oi horizons and the more decomposed Oa horizons. They are partly altered both physically and biochemically and evident fibers are largely destroyed when the vet organic material is rubbed. Some of the former O2 horizons are included.

Mineral Horizons

Mineral horizons either: 1. are never saturated with water for more than a few *days* end have less than 20 percent organic carbon, or 2. are saturated with water for prolonged periods or artificially drained and have (a) less than 18 percent organic carbon if the mineral fraction is 50 percent or more clay, Or (b) less than 12 percent organic carbon if the mineral fraction has no clay, or (c) proportional organic carbon contents if the clay content is intermediate.

A - Mineral horizons that formed or are forming et or adjacent to the surface, in which the feature emphasized is either (1) an accumulation of humified organic matter intimately associated with the mineral fraction, or (2) the surface position of horizons lacking features diagnostic of E or B.

In A horizons of organic matter accumulation the mineral particles have coatings of organic material or the soil mass is darkened by organic particles; the horizon is as dark as, or darker than, adjacent underlying horizons. The mineral fraction of such horizons may be unaltered or may have been altered in a ❑ enner comparable to that of E or B. The organic fraction is assumed to have been derived from plant and animal remains deposited mechanically on the surface of the soil, or deposited within the horizon without translocation of humified material through an intervening horizon that qualifies for a horizon designation other the" A. I" warm arid climates A horizons may be less dark then adjacent underlying horizons and may contain only slight accumulations of organic matter; the mineral fraction may be unaltered or only slightly altered. Such horizons that lack features diagnostic of E or B are designated A on the basis Of surface position.

AB - A transitional horizon between A and B, and dominated by properties characteristic of the A but having some subordinate properties of an underlying B.

No distinction is made between the different kinds of horizons that are transitional from A to different kinds of B; they obviously may be quite unlike one another but the burden of characterization rests on the description of the transition horizon plus inferences that can be made from the symbols assigned to the overlying and underlying horizons. The symbol AB normally is used only if the horizon is underlain by a B horizon. However, where the profile is truncated below in small places by rock, so as to eliminate the horizon that would be designated B, the symbol AR may be used for the horizon that is above the rock.

The symbol AB is confined to those kinds of transitional zones in which properties of the underlying B are superimposed on properties Of A throughout the soil mass. Those kinds of transitional zones in which parts that are characteristic of A enclose parts characteristic of B are classified as A&B.

A&B - Horizons that would qualify for A except for included parts constituting less then 50 percent of the volume that would qualify as B.

I" soil profile descriptions end in narrative discussions the designation is A&B, never A and B.

AC - A horizon transitional between A and C, hating subordinate properties of both A end C but not dominated by properties characteristic of either A or C.

B - Horizons in which rock structure[1/] is largely obliterated end in which the feature or features emphasized is one or more of the following: (1) an illuvial concentration of silicate clay, iron, aluminum, or humus, alone or in combination; (2) a residual

---

[1/] Rock structure includes fine stratifications in unconsolidated sediments or pseudomorphs of weathered minerals retaining their relative positions to each other end to unweathered minerals in saprolite from consolidated rocks.

concentration of sesquioxides or silicate clays, alone or mixed, that has formed by means other than solution and removal of carbonates or more soluble salts; or (3) an alteration of material from its original condition in sequa lacking conditions defined in (1) and (2) such that rock structure is obliterated and silicate clays are formed, oxides are liberated, or both, or granular, blocky, or prismatic structure is formed.

It is necessary to be able to identify the kind of B before one can establish that a horizon qualifies as B. There is no common diagnostic property or location in the profile by means of which all kinds of B can be identified; but B usually is a subsurface horizon. There are marginal cases in which a horizon might qualify as either of two kinds of B. In such cases the horizon description should indicate the kind of B that characterizes the dominant condition in the judgment of the person describing the soil. Laboratory work may be needed for identification of the kind of B, or even to determine the given horizon is a B.

That part of the B horizon where properties on which the B is baaed are without clearly expressed subordinate characteristics indicating that the horizon is transitional to an adjacent A, E, or C horizon is assigned an appropriate lover case letter suffix. B horizon collectively includes the transitional horizons BA, BE, BC as well as the parts that are without clearly expressed subordinate characteristics.

BA - A transitional horizon between B and A in which the horizon is dominated by properties of an underlying B but has some subordinate properties of an overlying A. The symbol BA is confined to those kinds of transitional horizons in which some properties of the overlying adjacent A horizon are superimposed on properties of B throughout the mass of the transitional horizon. Those kinds of transitional horizons containing parts characteristic of B separated by abrupt boundaries from parts characteristic of an overlying A are classified as B&A.

BE - A transitional horizon between B and E in which the horizon is dominated by properties of an underlying B but has some subordinate properties of an overlying E.

An adjacent overlying E and an adjacent underlying B are essential to characterization of a horizon as BE in a virgin soil. The horizon may still be recognized in a truncated soil by comparing the truncated profile with a profile of the same soil that has not been truncated. The symbol BE is confined to those kinds of transitional horizons in which some properties of the overlying adjacent E horizon are superimposed on properties of B throughout the mass of the transitional horizon. Those kinds of transitional horizons containing parts characteristic of B separated by abrupt boundaries from parts characteristic of E are classified as B&E.

B&E - A horizon qualifying as B in more than half of its volume and including parts that qualify as E.

Such horizons may have many thin tongues of E material that extend downward into the B from an overlying E horizon. They may have thin horizontal bands of E material which lie between thicker bands of B that are connected with tongues extending from an overlying E. Many B&E horizons consist of peds of B material having thick coatings of E material. The immediately overlying horizon or the underlying horizon, or both, in these instances may be a Bt horizon. The B&E designation should not be used unless the volume of E material is roughly 10 percent or more of the volume of the horizon.

In profile descriptions and in narrative discussions the designation is B&E, never B and E.

BC - A transitional horizon between B and C or R in which the properties diagnostic of an overlying B are clearly expressed but are associated with clearly expressed properties characteristic of C or R.

The designation BC is used only if there is an overlying B; thin applies even though the properties diagnostic of B are weakly expressed in the profile. Where an underlying material presumed to be like the parent material of the solum is absent, as in A, B, IIC profiles, BC is used below B in the sense of a horizon transitional to an assumed original parent material. "se of the symbol IIC involves an estimate of at least the gross character of the parent material of the horizons above it. BC in such cases is based on this estimate of the properties of the parent material of the B. BC is not used as 8 horizon transitional from IB to IIC or IIR.

E - Mineral horizons in which the feature emphasized is loss of' clay, iron, or aluminum with resultant concentration Of quartz or other resistant minerals in sand and silt sizes.

Such horizons are commonly, but not necessarily, lighter in color than a" underlying B. In some soils the color is determined by that of the primary sand and silt particles, but in many soils, coats of iron or other components mask the color of the primary particles. An E horizon is most commonly differentiated from an overlying A by color and is generally measurably lower in organic matter. A" E is most commonly differentiated from an underlying B in the same profile by lighter or weaker color, or coarser texture, or both. E horizons are commonly "ear the surface, below en O or A horizon and above a B, but the symbol E may be used either above or below subsurface horizons; position in the profile is not diagnostic. For horizons at the surface that would qualify equally well either a.8 A or E, the designation A is give" preference over E.

E&B - Horizon6 that would qualify for E except for included parts constituting lees than 50 percent of the volume that would qualify as B.

Commonly E&B are predominantly E material surrounding thin columnar-like upward extensions of the B horizon or wholly surrounding small isolated bodies that would qualify as B. Horizons designated E&B commonly lie between an overlying E and an underlying Bt or between adjacent B horizons.

I" profile descriptions end in written narratives the horizon designation is always E&B, never E and B.

C - A mineral horizon or layer, excluding indurated bedrock, that is either like or unlike the materiel from which the solum is presumed to have formed, commonly little effected by pedogenic processes, and lacking properties diagnostic of A, E, or B but including materials modified by: (1) weathering outside the zone of major biological activity, (2) gleying, (3) accumulation Of calcium or magnesium carbonates or more soluble salts, including degrees of accumulation such that noncarbonate *grains* are physically moved "part., (4) cementation by such accumulations of calcium or magnesium carbonates or more soluble salts, or (5) cementation by alkali soluble siliceous material or by iron and silica.

This definition is intended to include sediments end soft rocks in which rock structure is little affected by soil forming processes. It is intended to exclude horizons that meet the requirements of A, E, or B but to include certain kinds of alterations that historically have bee" considered to be little influenced by the activity of organisms. These alterations include chemical weathering deep in the soil. Some soils are presumed to have developed in materials already highly weathered and such materiel that does not meet requirements for A, E, or B is considered C. Accumulations of carbonates, gypsum, or more soluble salts are permitted in C if the material is otherwise considered to be little affected by other processes that have contributed to genesis of associated horizons. Such horizons are designated as Cca, Ccs, Csa. Even induration by such materials is permitted and this can be indicated by the suffix m, es in Ccam. Induration by alkali soluble siliceous material is also permitted and may be indicated by Csim. Induration by iron and silica does not exclude the horizon from C end horizons or layers thus indurated may be designated Cm. The C horizon as defined is intended to include the diagnostic horizons indicated by ca, cs, and sa, end the alkali soluble pans, the iron silica pens, and the fragipans, provided these layers do not meet the requirements Of A, B, or E. Soft sedimentary rock, such as some sandstones, siltstones, marls, or shales, that can be dispersed more or less completely by shaking in water or in sodium hexametaphosphate and that, when moist, can be dug with a spade are included in C.

Historically, C has often incorrectly been called parent material. I" fact, it is impossible to find the parent material from which the A, E, and B horizons have developed; that material has been altered. For thie reason C "ever was parent material, but was merely presumed to be like parent materiel. As C is now defined, this assumption is dropped.

R - Underlying continuous, indurated bedrock, such as granite, sandstone, or limestone.

The bedrock is sufficiently coherent when moist to make hand digging with a spade impractical although It may be chipped or acreped with 8 spade. Fragments cannot be dispersed by shaking in water or in sodium hexametaphosphate. The bedrock may contain cracks but these are few enough and small enough that there has not been significant displacement of parts with respect to one another. If presumed to be like the parent rock from which the adjacent overlying layer or horizon was formed, the symbol R is used alone. If presumed to be unlike the overlying material, the R is preceded by an arabic numeral denoting lithologic discontinuity as explained under the heading "Conventions Governing Use of Symbols."

6. Symbols used to indicate departures subordinate to those indicated by capital letters.

This section of the 1962 Supplement should be edited to make it consistent with changes in horizon symbols and changes in conventions governing the use of symbols. Other changes from the items in the 1962 Supplement that are being proposed follow. This is not a complete list; only symbols for which modified definitions are proposed and new symbols are included below.

b - Buried soil horizon

Add to the definition "The symbol b is not applied unless the overlying material is more then 25 cm thick."

g - Strong gleying in soils that are saturated with water at some season or are artificially drained.

(Otherwise, no changes from 1962 Supplement.)

h - Accumulations of partially decomposed organic matter. The symbol is applied: (1) to A horizons of organic matter accumulation, as Ah; and (2) to B horizons with illuvial organic matter, appearing as dark coatings on grains or as discrete dark pellets of silt size, as Rh.

Note: The need for guidelines for the use of symbols h and ir for B horizons of Spodosols has been noted but the committee has not proposed guidelines. M. E. Austin commented on the use of Bh and Bir for spodic horizons as follows: "As nearly as I can tell the distinction between the two in the past has been baaed almost entirely on color. Those horizons that have value of less than about 3.5 and chroma of 2 and less were called Bh; those of higher value and chroma Bir. As nearly as I can tell the usage had no relation to chemistry of the horizon. It now appears that many of the horizons that have been labeled Bir in the past contain organic matter and aluminum, but little or no iron. It would seem that distinctions made in the past have little or no meaning, and I doubt that we have enough data to make meaningful distinctions. Perhaps we could use Bse sesquioxides."

We could retain h, as provided above and adopt se for "illuvial accumulations of aluminum or iron, or both, with accessory organic matter" to replace the symbol ir as it has been used in the past for B horizons of Spodosols.

m - Strong cementation - Induration

Add the following: "Cementation should be strong enough that an air-dry fragment will not slake or fracture when placed in water, even with prolonged wetting.

si - Cementation by siliceous material, soluble in alkali

Delete the restriction that the symbol si may be applied only to C. B horizons and buried A and E horizons may be cemented by alkali soluble siliceous material.

x - Fragipan character

Edit to be consistent with the proposed use of E in place of A2 and delete the special conventions for use of x. Add the following: "Fragipans having a significant accumulation of illuvial clay may be designated Bxt."

pl - Plinthite

This symbol may be applied to the designation of any mineral horizon to emphasize the occurrence of a significant volume of plinthite in the horizon. (Substitute a definition of plinthite for the definition of laterite that now occurs on p. 185 of the Supplement.)

ox - A residual concentration of sesquioxides.

The symbol ox is used only with B, as Box.

s - Structure

For use only with B horizons to indicate kinds in which silicate clays are formed, oxides are liberated, or both, or granular, blocky, or prismatic soil structure is formed.

u - Unspecified kind of A or B horizon

Notes on horizon definitions and designations

1. The proposal to use E in place of A2 was supported by a large majority of the committee. One member commented that neither the present nomenclature nor the proposed use of E clearly expresses the genesis of soils in which clay translocation is an important process. In such soils the E or A2 has lost clay, but no more than the Al. If lover case letter e were used with A, instead of E, one could distinguish strongly eluviated Al horizons from weakly eluviated ones and sequences of horizon symbols could be more meaningful; for examples: Ah, Bs, C; Ahe, Ae, Bt, C. On the other hand, the proposed use of E makes it possible to define A as a surface horizon, which simplifies the notation for extensive arid soils and at the same time works to preserve the historical A-B-C depth sequence.

2. K horizon. Vigorous arguments were made for the addition of K as a new master horizon for prominent accumulations of pedogenic carbonate. The subcommittee on soil horizons was equally divided for and against the proposal and they did not make a recommendation. Subsequent to the subcommittee report a number of people expressed an opinion that K should not be added as a master horizon and only one argued again for the proposal, The main argument against use of K is that it represents 8 prominent degree of expression of a genetic process rather than 8 major kind of genetic departure from parent material. It is argued that recognition of master horizons for outstanding accumulations of clay, iron, silica, gypsum, organic matter, etc., would be equally valid. A different system of horizon notation than the present one would be required.

3. The conference should be aware of one possible alternative to the proposal for K and to the current conventions for such horizons. It has bee" suggested that a master horizon, such as S, be recognized for mineral horizons believed to have been altered chiefly by accumulation of magnesium carbonate or more soluble salts. It would in a way be analogous to some kinds of B. This would simplify the concept and definition of C and would give more emphasis to prominent accumulations of the more soluble soil constituents than the present horizon designations. There would be problems in determining which takes precedence as between Bca and Sca, or between Aca and Sca; definitions and conventions would need to be worked out.

4. Note that surface position is emphasized in the proposed definition of A.

5. Note that the definition of B has been simplified and expanded to include "structure B's."

6. Note that the statement concerning C horizon has been changed so that fragipans do not need to have distinct clay concentrations to be designated Bx.

7. Some have thought there is a conflict in the use of layer and horizon in the discussion on page 173 of the Manual. The subcommittee recommended that the term "layer" be restricted to non-genetic sections. The chairman thinks that drawing a firm distinction between soil horizons and soil layers will cause more difficulties in terminology than it is worth. One can always specify "genetic horizons" if he wishes to exclude other kinds. Because most elements of horizon designations are defined in genetic terms, a distinction between genetic soil horizons and layers that have not resulted from pedogenesis is superfluous for many situations. A soil horizon could be defined simply as a layer of soil, approximately parallel to the soil surface, with characteristics that differ from adjacent layers.

8. Recommendations of the subcommittee that horizon designations B&R, C&R, R&B, and R&C be added to the approved list have not been accepted. The concepts of such horizons would conflict with the concept Of R. If they were accepted, they surely would be used

incorrectly to label horizons composed of rock fragments in a finer matrix. One CM describe cracks or fissures in bedrock filled with material like an overlying C or B, or tongues of B extending into fissures in R, or projections of R into C or B, if the more simple device of describing an irregular horizon boundary will not Suffice.

9. A discussion of solum and a proposed definition are in the Appendix.

Discussion by the Conference of the proposals on horizon designations

1. It was pointed out that the proposal to use symbols Oa, Oe, and Oi for organic horizons of miners1 soils has not been well tested. A number of people expressed uncertainty or misgivings about how well those symbols would work for relatively well-drained mineral Soils. A proposal to use master horizon symbol H for organic horizons of mineral soils was favorably received. R. Dudal observed that the proposal to "se H for the present 0 horizon would conflict with the current proposals of the International Society of Soil Science.

2. L. P. Wilding observed that the A&B horizon designation of the present Manual becomes E&B in the proposal. The proposed symbol A&B is a" addition to what is provided in the present Manual.

3. The proposed definitions exclude materials that would qualify for a paralithic contact from R and include them in C. M. Stout argued that a symbol is needed to designate such material. R. B. Grossman suggested a suffix r for a root limiting layer, such as Cr. It was pointed out that this would include Some glacial till and other sediments es well as shales and other weakly consolidated rocks. J. E. McClelland argued that a symbol to designate materials fitting the concept of paralithic contact should be added; he would not be concerned if that Should include some glacial till and other materials. Guy Smith indicated there is a conflict between the proposed definition of R and the definition of lithic contact in Soil Taxonomy, which requires the average spacing between cracks in rock to be greater than 10 cm. Carlisle commented that one of the assumptions for the horizon symbols was that their definitions should be compatible with the Soil taxonomy but that they should not be equated with diagnostic horizons or diagnostic features of the taxonomy. Thus, the definition of R is consistent with the definition of lithic contact but they do not have identical definitions.

   The phrase "consolidated bedrock" was changed to "indurated bedrock" in the proposed definitions of C end of R.

4. J. R. Coover asked how one Should designate a secondary accumulation of calcium carbonate in cracks in the upper part of an R layer. Would Rca be a" acceptable horizon designation?

5. K. W. Flach Suggested that the definition of the Suffix si be modified to include cementation equivalent to suffix m. The" the suffix si could replace the present sim.

6. R. B. Grossman observed that the Suffix ox was likely to be taken as connotative of oxic horizon. He suggested that sq be substituted for the proposed ox.

7. Grossman suggested that two lower case letter symbols be provided for accumulations of calcium carbonate. The symbol "ca" could be used for accumulations up to 90 percent of K-fabric and "k" for 90 percent or more of K-fabric. Arguments against this proposal were similar to those against adopting master horizon K. The proposal was for a special Symbol for a" outstanding accumulation of carbonates, but we have not provided special symbols for outstanding accumulations of other constituents. We have avoided equating horizon Symbols with diagnostic horizons.

8. I,. J. Bartelli expressed doubt that the proposed symbol "pl" should be provided for the occurrence of plinthite. This was related to the discussion on relating horizon symbols to diagnostic horizons or features.

9. R. J. Arkley questioned the desirability of the proposed convention that would limit the number of lower case suffix symbols to two for any horizon designation. The intent of that convent is to curb a tendency to try to characterize the horizon in the horizon designation. Symbols having many lower case letter components lose their usefulness; they are overloaded.

10. A. C. Orvedal observed that the lower case letter components of the horizon symbols will be a problem for most computer system printers. The position of the committee was that

the capacity of current computer printers should not limit our alternative*. There are some problems but these can be worked out.

11. R. Dudal observed that the system of horizon symbols being proposed by the International Society of Soil Science would (a) hold the number of lower case letter suffixes to a minimum, (b) limit lower case letter symbols to one letter, instead of using two-letter symbols such as ca, (c) not use lower case letters es part of a master horizon symbol, (d) not include master horizon symbols K or G. The committee considered using only single-letter lower case letter symbols end decided the saving in length of symbols would not compensate for the changes thet would be required.

12. Dr. Kellogg commented that we do not went to be slaves to computer systems, but on the other hand, we do want to be practical. He indicated we should try to get es much agreement es we can with other systems of horizon nomenclature. He asked thst we reexamine the use of lower case letter symbols in other systems of horizon designations to see if alternative symbols should be adopted.

The Conference accepted in principle the proposed conventions and definitions with the understanding some changes in symbols may be desirable.

E. Soil Textural Classes and Coarse Fragments

1. Soil texture.1 classes. This committee considered whether the textural classes es defined in the Soil Survey Manual should be revised to provide simpler relations between the textural clashes and the limits of the family classes.

The lack of coincidence of family class limits (called particle-size classes in Soil Taxonomy) with limits of textural classes for descriptions of *oils is inconvenient and is the source of several difficulties. Accurate description* of soils in terms of the textural classes commonly do not provide sufficient information on texture to classify the soils into families or series. Descriptions of pedons, of soil mapping units, and of soil series must provide information on particle size distribution beyond that provided by the textural classes in order for the *oil* to be classified accurately in most instances. Moreover, because the 'particle size classes" for the family grouping* treat the very fine sand size separate as sand if the material is sandy and as silt if finer than that, it is very difficult to depict in a diagram the relationships between the two sets of classes; the units on two sides of the "texture triangle" for the standard textural classes are different than those for the family particle size classes.

On the other hand, a very large amount of information exists in terms of the present textural. classes. If the textural classes are changed very much, much of that information, which includes series descriptions and published soil surveys, will become "dated" and obsolete with respect to the description of texture.

Material reviewed by the subcommittee included the Soil Survey Manual, pages 205-223; SSSA Committee Report on Considerations Relative to a Common Particle Size Scale of Earthy Materiels (SSSA Proc. 31: 579-584, 1967); paper on Evaluating Expressions of Particle Size Distribution by V. C. Jamison; and a study by Dr. Flach of field texture determinetions and particle size distribution classes for 1600 or so samples from the Western States.

The report of the subcommittee to Committee 3 es a whole was followed by more correspondence and discussion of proposal*. Dr. Flach made additional studies of relationships between field texture determinations of soils in the Western States and proposed textural classes. The proposal* outlined here are based on the subcommittee report and the subsequent correspondence and discussions.

The committee concluded that the advantages of having standard textural class limits coincide with family limits for the less than 2 mm fraction would outweigh the disadvantages of making the change. Of several alternatives considered, the one favored by a majority of the committee was (1) to provide standard texture classes that are subdivision* of the family limit* for the size fraction less than 2 mm and (2) to adopt the MIT scale for particle size classes. A second alternative was to change the limits of the texture classes to conform to the 60 percent clay, 35 percent clay, end 18 percent clay limits of the family classes but to retain other class limits, including the present USDA-SSSA particle size classes. A third alternative was to continue the present standard textur classes and particle size scale.

A proposed set of textural classes, as suggested in the first alternative listed above, is illustrated in Figure 1. Additional testing of that set of classes and of alternative class limits would be needed before changes in the standard textural classes were adopted by the Soil Survey. Some results of tests by Klaus Flach of the classes outlined in Figure 1 were presented in tables and figures that were included in the report to the Conference at Charleston. Those data are not included in this document but copies can be sent to individuals if a request for them is directed to the committee chairmen. The tests were on soil samples from the Western States that had been analyzed at the Soil Survey Laboratory in Riverside.

Table 1 presents proposed names for the proposed textural classes end a proposed grouping of those to provide general texture terms comparable to the ones provided in the present Manual. The silt loam, silty clay loam, loam, and clay loam classes of the present system do not have closely similar counterparts in the proposed classes. Using different names for classes that are appreciably different would help to prevent confusion between the present set of classes and the proposed classes.

Table 1. Proposed Names for Proposed Textural Classes

Standard textural class	General terms	
coarse sand[1/] medium sand fine sand	sends	sands
coarse sandy loam[1/] sandy loam fine sandy loam silty loam	coarse loams	loams
sandy clay loam clayey loam	fine loams	loams
silt	coarse silts	silts
clayey silt	fine silts	silts
sandy clay loamy clay silty clay	coarse clays	clays
clay	fine clays	clays

1/ The proposed textural classes of sands and of sandy loams were defined as follows:

a) Coarse sand and coarse sandy loam: 40 percent or more of the sand fraction is coarse sand (larger than 0.6 mm).

b) Fine sand end fine sandy loam: 50 percent or more of the sand fraction is fine sand (lees then 0.2 mm).

c) Medium sand and sandy loam: other sands and sandy loams, respectively.

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

GUIDE FOR TEXTURAL CLASSIFICATION < 2 mm fraction

May 1, 1950

MIT particle size scale

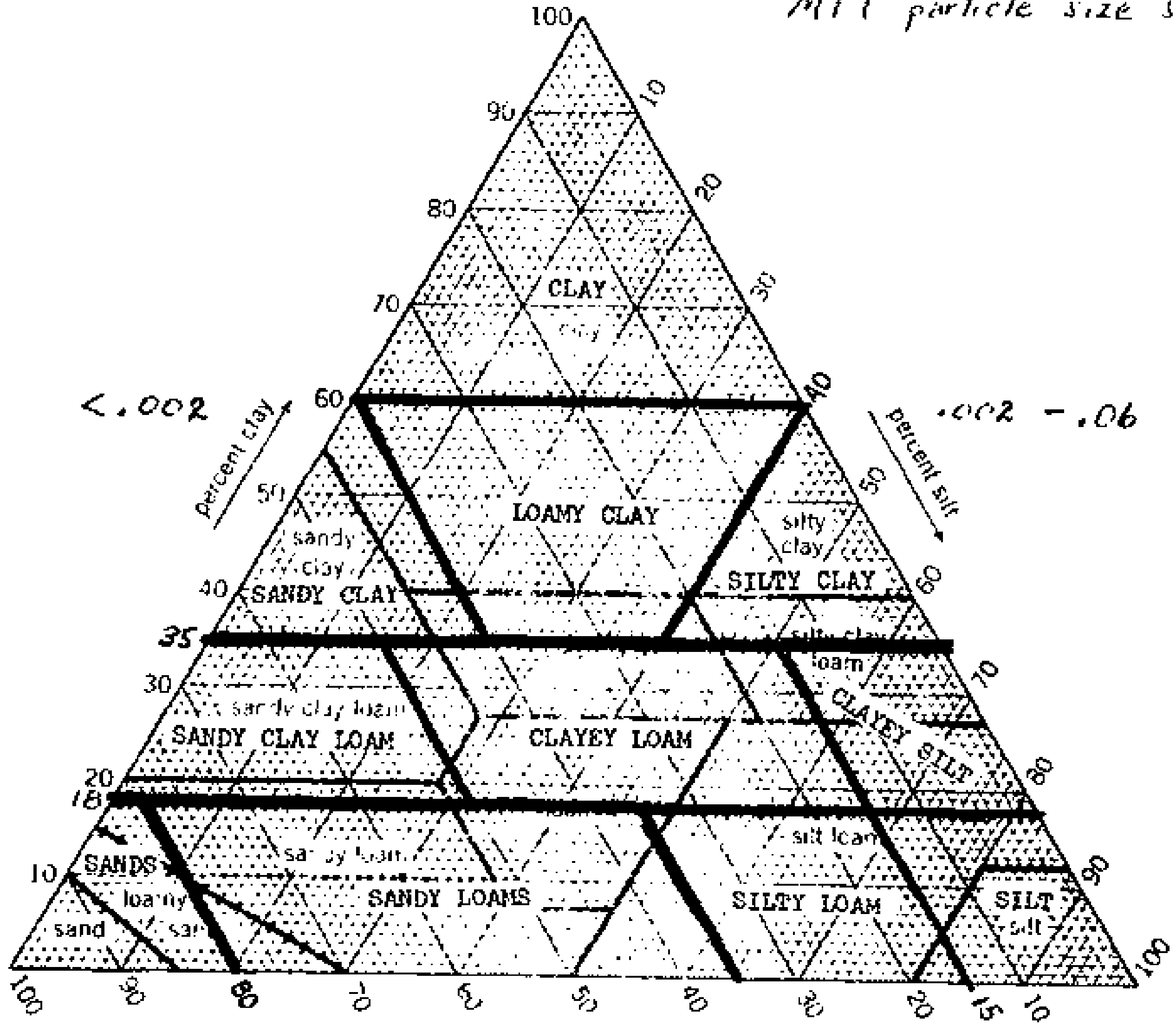


Figure 1

2. Coarse fragments. This section is concerned with conventions for the description of coarse fragments in descriptions of horizons and layers of soils. It is not concerned with naming kinds of soil, as when assigning names to mapping "nits.

The subcommittee recommended that the conventions for including names of coarse fragments as modifiers of texture class names that are specified in the 1951 Manual be continued, with slight modifications. That is, in descriptions of soil materials the terms gravelly, channery, cobbly, end flaggy would be used as modifiers of soil texture class names when that is appropriate; and the term stony is not to be so used. Volume Of stones would be described separately for the pedon. It was suggested that cherty, slaty, end shaly be dropped as modifiers of texture class names for descriptions of soils.

The subcommittee recommended that the modifier gravelly be used for materials containing between 15 and 35 percent gravel by volume and that very gravelly be used for 35 to 70 or 80 percent gravel by volume. Ninety percent by volume Of coarse fragments is said not to occur. By extension, the same limits would apply to the use of channery and very channery, cobbly and very cobbly, and flaggy and very flaggy.

It was suggested that a guide for relating volume percentages to weight percentages should be included in the revised Manual.

The following two alternatives to the subcommittee's recommendation were also "resented for consideration by the Conference.

a) Use the descriptive words for coarse fragments only as phase terms in names of kinds of soils; discontinue their "se as modifiers of texture class names in descriptions of soils; describe size and volume of coarse fragments in descriptions of soils.

b) Permit use of the descriptive terms for all coarse fragments, including stony, as modifiers of texture class names in the descriptions of soils. and include in the descriptions a statement of estimated volume of coarse fragments.

3. Discussion by the Conference.

a) Soil textural classes. The Conference accepted in principle the committee's suggestion to provide standard textural classes that are subdivisions of the family classes. The Conference rejected the proposal to adopt the MIT particle size scale. It suggested instead (1) that the 0.05 to 0.1 mm size fraction (the present very fine sand fraction) be included in silt so the limit between sand and silt would be 0.1 mm, (2) that the 0.05 to 0.1 mm fraction continue to be determined in analyses of particle size distribution, and (3) that the definitions of the family class limits be amended to coincide with this proposed change.

Most of the discussion concerned the size limits of the soil separates used to define the textural classes, especially the limit between silt and sand. Alternatives discussed were the present limit of 0.05 mm, the 0.063 mm limit of the MIT particle size scale, the 0.074 mm limit used in the AASHO and Unified classifications, and 0.1 mm.

The proposed textural classes illustrated in Figure 1 would eliminate the present distinction between the sand and loamy sand classes, and several people questioned the wisdom of such a change. The reasons for the proposed change in that part of the texture triangle were two-fold. First, a simpler definition of the limit between the sandy classes and the sandy loams "as wanted. Second, the present classes are relatively narrowly defined and reliability of identification in the field has been relatively low.

The proposed names for the proposed textural classes were discussed and several changes were made. The changes are reflected in the table included in this report.

b) Coarse fragments. The conference was not satisfied with the recommendation of the subcommittee with respect to conventions for describing coarse fragments nor with the alternatives presented by the committee. The Conference recommended the following conventions:

The names of all classes of coarse fragments, including stones, are to be used as modifiers of textural class names in descriptions of individual horizons when that is appropriate. Materials having 15 to 35 percent by volume of coarse fragments are to be described as gravelly, cherty, channery, etc., as appropriate; for example, gravelly loam. Materials having more than 35 percent by volume of coarse fragments are very gravelly, very cobbly, etc. Size and volume of coarse fragments greater than 10 inches in diameter are to be described for the pedon if possible. The "se of cherty, slaty, and shaly as modifiers of textural class names in descriptions of soil horizons is to be continued. It was further recommended that the term "cindery" be added to the list of names of coarse fragments.

No objections were voiced to a proposal to provide descriptive names for subdivisions of the gravel fraction on the basis of size. The proposal was as follows:

fine gravel	2-5 mm
medium gravel	5-20 mm
coarse gravel	20-76 mm

F. Soil Structure and Consistence

Soil Structure

The following suggestions end comments on standards for describing structure were made by the committee. These were not discussed by the Conference at Charleston.

1. One suggestion to the committee was for addition of cylindroid as a new type of structure for cylindrical peds that form from filled burrows of cicada nymphs. The cylindroids are said to occur extensively in soils in the Western States and to compose the main structural expression in some soils. The 1970 Western Regional Committee on Soil Structure and Fabric recommended that the term cylindroid be applied to these pede and that they be treated as special features of soil horizons. Members of the present committee who reacted to the proposal did not think the new structure type should be adopted. The committee chairman suggests that the cylindroids be treated as special features of horizons as recommended by the Western Regional Committee.

2. Participant8 in the November 1970 Correlation Workshop at Lincoln seemingly were in general agreement that conventions for the description of soil structure should be used to describe fragments as well as peds and to specify when the terms were being applied to fragments. It is understood that fragments refers to "natural aggregates" in the soil that are thought to be bounded by ephemeral planes which do not persist through seasonal cycles of moisture or volume changes. By "natural aggregates" is meant aggregates that exist in the soil when the soil is observed and not fragments that are created by the observer. Other correspondents have expressed concern that more attention should be given to the distinction between fragments and peds in the description of soil structure. The suggestions seem parallel in some respects to proposals in the 1968 Western Regional Committee on Soil Structure concerning a distinction between soil structure and pedality that was discussed by the 1969 National Committee on Criteria for Series and Phases. The statement in the report of the 1969 National Committee is reproduced below.

   "Proposal to distinguish soil structure from soil peds (pedality)"

   "1. Peds or 'natural structure' should be considered a dynamic property (that varies with) time and moisture.

   "2. Structure (no distinction as to ped, clod or fragment) is the size, shape and durability-distinctness of whatever aggregates are present at the time the pedon is described with specified moisture content.

   "3. Structure is reserved for pedon descriptions and pedelity is reserved for series class definitions.

   "The committee agreed that it is necessary to observe several pedons of a series under varying moisture conditions and over a period of time in order to determine whether a soil series has peds or pedality because observations on a single pedon et any one time may not reveal the range in structural regimes present in the soil.

   "The National Committee and the conference agreed to adopt the above proposals for trial use."

The foregoing comments indicate a slightly different concept of soil structure or at least suggest 8 slightly different definition of soil structure than the one given on page 225 of the Manual. Committee 3 did not express a judgment on this item.

3. Size classes for describing soil structure.

a) The current size classes for platy structure work well for descriptions of many A2 horizons but the classes often are too thin for descriptions of B3 and C horizons. It was suggested that the thickness limits for blocky classes (5, 10, 20, and 50 mm) be used in place of the current platy class limits (1, 2, 5, and 10 mm).

An alternative is to retain the current class limits and to specify the average thickness for plates that are appreciably thicker than 10 mm, as proposed below.

b) The lack of an upper limit for the very thick and very coarse classes of structure sometimes results in incomplete descriptions and a loss of significant information about soils having very large structural features. For example, it would sometimes be well to have a record of whether the strong very coarse prisms in the B3 horizon are mostly 12 cm wide or mostly 40 cm wide. Instead Of putting upper limits on the very coarse classes or adding classes, it is suggested that a convention along the following lines be included in the revised Manual: If the dimensions of large structure units are more than twice the lower limit of the very thick or very coarse class, the description of structure should include a statement of the dimensions. Examples: Moderate very coarse prisms are 20 to 40 cm wide; weak very thick platy, plates mostly about 3 cm thick.

4. The recommendation often made in the past that moisture status should always be specified when describing soil structure is supported by the present committee. The committee suggests that the standards included in the revised Manual for describing moisture state generally be used for indicating moisture content at which soil structure is described. Suggested conventions for describing moisture state are included in the report of Committee 9. The Appendix to this report includes moisture status definitions proposed by the 1968 Western Regional Committee for use with soil consistence evaluations. These were recommended by the 1969 National Committee on Criteria for Series and Phases for trial use, and several of the present committee have suggested they would be useful for describing the moisture condition at which soil structure is described.

Soil Consistence

W. D. Nettleton studied the relationships between field descriptions of moist and dry consistence and measurements in the laboratory of unconfined compressive strength and between field descriptions of stickiness and plasticity when wet and Atterberg limits. Some of his data and suggestions to the committee are given in the Appendix. His findings are important to the design of classes for the description of consistence in the field. They show that, in terms of unconfined compressive strength, the classes in the lower range of the moist consistence scale are very poorly differentiated in the field and that the spans of both ❑ oiet and dry consistence classes increase markedly toward the higher end of the scales. The data on vet consistence suggest that four classes may be too many for field estimates of stickiness and plasticity.

The following proposal by R. B. Grossman for the description of consistence in the field was discussed by Dr. Grossman at the Conference.

The discussion of field class placement to follow would be part of three related sections in the revised Manual. The other two sections would deal with quantification beyond or supplementary to the tests employed for the field placement, and the relationship of the new class placement proposal to the soil taxonomic system.

It is suggested to drop the term "consistence" for the overall subject, restricting its application to the tests described under "consistence when wet" in the present Manual. In its place, the term "soil rheology" is suggested. Rheology is "a science dealing with the deformation and flow of matter."

The proposal for field class placement assumes that the water status of the horizon would be part of the description. A set of terms for the water status are given in the appendix to the report of Committee 9. It is proposed to have two standard moisture conditions: air-dry and at the transition between vet and dry. The definition of taxa and of series concepts would employ these standard states if they are pertinent. Other standard states may be useful. It is recognized that the transition between wet and dry rarely would be observed. Rut the rheological properties across the transition may be estimeted from observations at water tensions above and below the tension stipulated for the distinction between wet and dry. Selection Of the wet/dry transition as a standard state permits the coordination between field and laboratory determinations, since the laboratory determinations presumedly would be at a tension that marks the transition between moist and vet.

1. Unconfined failure

1.1 Strength

1.11 Tests

The specimen should be 3 cm across end roughly equidimensional. If feasible: the two bearing surfaces should be roughly parallel and smooth. For the hand-held tests, apply the stress slowly (3 sec. interval) until failure is just perceptible. Apply the stress parallel to the in-place vertical axis unless otherwise specified, or the test is performed on equidimensional structural types. Stress should be applied only once to a specimen. A minimum of three specimens should be tested. If all three specimens do not fall in the same class, the placement should be based on five specimens.

If grade of structure is weak, report only observations on the test specimen.

If grade is moderate and the structural units are between 0.5 and 3 cm in the smeller dimension, the failure of both the test specimen and the structural unit may be reported.

If grade is strong, use the dominant structural unit as the test specimen if larger than 2 mm in the smaller dimension. Do not shape unless the minimum dimension is greater than 3 cm.

To test for cementation, an sir-dry test specimen is placed in water for one hour and the strength determined while still wet.

1.12 Classes

Loose: Test specimen cannot be obtained because adhesion between the constit- particles is too smell; condition related to low clay, not to high water content.

Very slight strength: Fails under 1 kg (very gentle pressure) exerted slowly between thumb and forefinger.

Slight strength: Withstands 1 kg but fails under 2 kg (gentle pressure) exerted slowly between thumb and forefinger.

Moderate strength: Withstands 2 kg but fails under 4 kg (moderate pressure) exerted slowly between thumb and forefinger.

High strength: Withstands 4 kg exerted between thumb and forefinger but fails when placed on a hard surface and 16 kg (gentle pressure) applied slowly with the foot.

Very high strength: Withstands 16 kg but does not support 80 kg when placed on a hard surface and stress applied slowly with the foot.

Extreme strength: Supports 80 kg when plsced on a hard surface and stress applied slowly with the foot.

Weakly cemented: High or very high strength.

Strongly cemented: Extreme strength but breakable with a sharp forearm hammer blow.

Indurated: Not breakable with a sharp forearm hammer blow.

1.2 Yield behavior

The manner of yield would only be applicable to soil material* that are high-moist or vet, as these terms are defined in the appendix to the report of Committee 9.

1.21 Tests

The test specimen used for placement in a strength class may be used to determine if brittle. The distinction between semi-brittle and ductile may be better determined if the width of the test specimen is twice the thickness. (Need to describe the test procedure for r-lovable classes.)

1.22 Classes

Brittle: Under slowly building stress fails abruptly into numerous fragments or peds with no evident deformation prior to rupture.

Semi-brittle: Although cracks develop on strain, deformation is observable prior to rupture; does not remain a single body when slowly strained to half the original thickness; a portion crumbles and falls away if shaken while held between the fingers.

Ductile: Deforms without the appearance of cracks; after strain to half the original thickness the specimen remains a coherent unit; none flows through the fingers when squeezed.

Slightly flowable: Flows with difficulty through fingers when squeezed leaving large residue in hand.

Moderately flowable: Flows easily through fingers when squeezed leaving small residue in hand.

Readily flowable: Flows very easily through fingers when squeezed leaving very small or no residue in hand.

2. Consistence

The term, consistence, as employed here pertains to the stickiness and the plasticity of thoroughly kneaded or otherwise disaggregated soil material for water contents above the plastic limit. Stickiness is the quality of adhesion to foreign objects. Plasticity is the ability to change shape continuously under a stress and to retain the unpressed shape on removal of the stress. The water content for both the determination of stickiness and plasticity should be at or near that required for the maximum expression of these properties. This is a higher water content than the plastic limit employed by soil engineers and the related plastic thread test (ASTM Designation D2488-69). Both stickiness and plasticity commonly increase with increasing degree of manipulation of the sample. The disaggregation should be as thorough as practicable for a field determination.

2.1 Stickiness

Soil material is pressed between thumb and finger and its adherence noted. Should greater than 0.5 mm be excluded? Should the "umber of classes be reduced?

Non-sticky: After release of pressure, practically no soil materisl adheres to thumb or finger.

Slightly sticky: After pressure, soil material adheres to both thumb and finger but comes off one or the other rather cleanly. It is not appreciably stretched when the digit* are separated.

Sticky: After pressure, soil material adheres to both thumb and finger and tends to stretch somewhat and pull apart rather than pulling free from either digit.

Very sticky: After pressure, soil material adheres strongly to both thumb and forefinger and is decidedly stretched when they are separated.

2.2 Plasticity

Roll the soil material between thumb and finger and observe whether or not a wire or thin rod of soil can be formed. Should greater than 0.5 mm be excluded? Should the number of classes be reduced?

Nonplastic: No wire is formable.

Slightly plastic: Wire formable but soil mass easily deformable. Flattening of a ___-cm long section of a 3-m thick ribbon to one-half its original thickness requires less than _kg.

Plastic: Wire formable and moderate pressure required for deformation of the soil mass. Flattening of a ___-cm long section of a 3-mm thick ribbon to one-half its original thickness requires _ to ___kg.

Very plastic: Wire formable and much pressure required for deformation Of the soil mass. Flattening "f a ___-cm long section of a 3-mm thick ribbon to one-half its original thickness requires greater than ___kg.

Discussion at the Conference of the proposals for field descriptions of soil consistence

I" response to questions, two points were emphasized regarding the proposed strength test. The proposal is for a standard volume element having 3 cm dimensions; if grade of structure is strong and dimensions of peds are between 2 mm and 3 cm, the dominant structural unit is used; if grade is moderate and dimensions of peds are less than 3 cm, the strengths "P both the standard volume and the dominant ped size would be reported. The second point was that the proposed standard terms for describing moisture state would be used to indicate moisture condition to which the field determination of "unconfined failure" applied.

Ten strength classes were thought to be too many by some people. However, it was pointed out that the ten classes actually are three separate series; the loose class stands by itself, and three classes are for cemented materiel.

It was observed that few series are set apart on the basis of consistence ""!a. Two step differences in the present consistence classes would be needed if consistence were to be wed in setting apart series.

Discussion by the Conference indicated support for moving toward more quantitative standards for the description of consistence than are provided in the present Manual. The report was accepted.

G. Report of Subcommittee on Roots, Pores, Concretions. Nodules, Accretions

The subcommittee considered comments in Appendix IV of the 1969 National Technical Work-Planning Committee on Criteria for Soil Series and Phases; the 1970 Northeast Soil Survey Work Planning Conference; the proposed coding scheme for soil characterization data in the pedon data file; and the Soil Survey Manual.

I" conjunction with other soil characteristics, the characteristic8 of roots, pores, concretions, nodules, and accretions have been used to infer soil genesis. They have seldom been used per se as diagnostic criteria. In Soil Taxonomy, however, certain of these features are used as diagnostic criteria as, for example, roots in fragipans. The subcommittee agrees that guidelines for definitions, morphology, amount and distribution of such features should be stated as precisely as possible.

1. Roots and pores

It is generally agreed that emphasis he given to the abundance, size and distribution of roots and pores. I" addition, continuity classes and morphology of pores, if significant, should be recorded (see item 1f, below).

a. Abundance classes - 'Three abundance classes are believed Sufficient:

Roots	Pores	No./Unit Ares of Surface*
few	few	3 or less
common	common	4 to 14
many	many	more than 14

*Unit area is a square inch for very fine snd fine Sizes;
S Square yard for medium and coarse sizes.

This recommendation departs from that of the 1969 NTWPC in that the classes very few and few of that report are combined as few. The size of the unit area of Surface might be changed to 10 cm for very fine and fine roots. This would conform with the intervals given in Soil Taxonomy for the presence of roots in fragipans.

The statement there reads "... It is characteristic of fragipans that few or many roots may be present in the brittle matrix between the bleached Streaks. The fine roots should not be present at intervals of less then 10 cm except in bleached vertical streaks."

b. Size classes - Four size classes are believed Sufficient:

very fine	-	less than 1 mm
fine		1 to 2 mm
medium	-	2 to 5 mm
coarse		over 5 mm

c. Distribution within horizons - The inped, exped proposal of the 1969 NTWPC is acceptable. This may need modification to accommodate conditions in which roots are confined to interfaces Of coarse prisms as opposed to interfaces of individual peds within the prisms. The term "prism faces" might be introduced to accommodate this condition.

c. Orientation classes - The vertical, horizontal, oblique, and random class definition given in the 1969 NTWPC committee report are acceptable (see item lf, below).

e. Morphology of pores

1) Type modifiers - The general consensus is that these (Simple, dendritic, open, closed) do not sdd enough to justify recording except, perhaps, for Special research. There is Some overlap in the definition given by the 1969 NTWPC committee.

2) Types of pores - These (vesicular, interstitial, tubular) are useful. Some areas have used the term "irregular" for "interstitial" but standardization should offer no problem.

f. Some members are concerned as to how much of items a through e above is needed for minimum Standards in Series descriptions. There is agreement that these items offer sufficient consideration for roots and pores snd that recording of additional features is optional. However, all of these items are not presently used snd it is doubtful that they will be unless, in the judgment of the field soil scientist, the feature is significant to the problem at hand. For example, present descriptions rarely show orientation Of roots and pores (item d). In the opinion of the subcommittee, certain lsttitude must be assigned the field soil scientist in describing such features. This does not relieve him of the responsibility of recording significant features but does allow a factor of judgment as to whether the item is Significant. For encoding Soil characterization data, provisions should be made for indicating that the item in question was not recorded. The interpretation would be that the field soil Scientist felt that the item was not Significant enough to warrant recording.

2. Concretions, nodules, and secretions

a. There were divergent comments from members of the subcommittee on these items. It is generally agreed that the Manual should expand this Section and thst clear definitions be set forth in conformance with a standard work in Sedimentary petrology. The works of Pettijohn, Brewer, and definitions in the Glossary Of Geology and Related Sciences are suggested for reference materials. The following definitions are from the Glossary of Geology and Related Sciences:

Concretion - A nodular or irregular concentration of certain authigenic constituents of sedimentary rocks and tuffs; developed by the localized deposition of material from solution, generally about a central nucleus. Harder than enclosing rock.

Nodule - Small more or less rounded body generally somewhat harder than the enclosing sediment or rock matrix.

Accretion - The process by which inorganic bodies grow larger, by the addition of fresh particles to the outside.

These definitions of concretion and nodule are unsatisfactory in that they overlap and also refer to rock instead of soil material. Pettijohn states that a nodule is not an ordinary concretionary growth. According to him, concretions are the product of accumulation of mineral matter in the pores of the sediment about a nucleus or center. It seems feasible, therefore, to differentiate concretions from nodules on the basis that concretion8 have a morphology consistent with a concretionary (growing together) process, whereas nodules are discrete bodies that fail this process.

Concretions and nodules both infer objects harder than the surrounding matrix end some members of the subcommittee feel that this excludes soft masses of mineral accumulation. The term "accretion" is used in some series descriptions to describe these conditions. According to the definition in the Glossary of Geology and Related Sciences, however, accretion refers to a process rather than a" object. In this sense the term has been incorrectly used and some members prefer to omit it from series descriptions. Webster, however, expands the definition to include "a whole resulting from such growth or accumulation." It seems that in soils literature there is an opportunity to define the term as a soft body of mineral material that has accumulated through the process of accretion and has the consistency of the matrix in which it is imbedded.

Consistency classes for accretions would, by inference, be the same as the surrounding matrix. Consistency classes for concretions and nodules would be referred to in terms of cementation, to include the three classes now listed in the Manual (weakly cemented, strongly cemented, indurated).

It is agreed that size classes for these features be confined to fine, medium, and coarse, the class limits to agree with those now used for mottles. A very coarse class for sizes greater than 7.5 cm might be appropriate.

The additional terms of "films and threads" are useful in dealing with lime or salt veins but outside the realm discussed here. The same is true for individual mineral crystals such as barium or gypsum that are imbedded In the soil matrix. These features need separate reference.

b. Summary for concretions, nodules, and accretions

Concretions - A nodular or irregular concentration of certain authigenic constituents within the soil matrix; developed, as evidenced by their morphology, by localized deposition of material from solution, generally about a central nucleus; a discrete body, harder than the surrounding matrix. Abundance and size classes should conform to those now used for mottle8 except that a very coarse class might be used for concretions greater than 7.5 cm in diameter. Consistency classes to be determined in terms of cementation.

Nodules - Discrete bodies, harder than the surrounding soil matrix, that lack the morphology of localized deposition found in concretions. Abundance and size classes and consistency the same es for concretions.

Accretions - Bodies of mineral material that have accumulated through the process of accretion and have the same consistency of the matrix in which they are imbedded. Size and abundance classes are similar to those now used for mottles.

3. The subcommittee agrees that the proposed scheme for encoding soil characterization data in the pedo" data file should be in agreement with classes stated in the Soil Survey Manual. Presently the scheme includes classes that have not been approved for general usage.

Discussion of the subcommittee report

The foregoing report was not discussed during the regular sessions of the Conference at Charleston. Immediately following adjournment of the Conference the report was discussed by some members of the Conference who remained for that purpose. The following notes pertain to that discussion.

a. Standards for descriptions of pores. The standards are for description of pores in field descriptions of soils, and they pertain to features that can be observed with the naked eye or hand-held magnifiers.

The proposed size classes for pores seemed acceptable to most of the participants, but a lover limit for the very fine class is needed. A proposal that the very fine class be defined as 0.1 to 1 mm seemed acceptable.

The unit area for the proposed abundance classes is one square inch. It was proposed that these be changed to the metric system and the group seemed agreeable to the following:

few		less than 5 per 10 sq cm
common	-	5-20 per 10 sq cm
many		more than 20 per 10 sq cm

A number of the group thought the proposal to describe distribution of pores as "inped" or "exped" should be dropped. Their thought was that the "exped" pores must be the roughly planar voids that are a function of sail structure, that roughly equidimensional or elongated, roughly tubular pores are the ones amenable to description in terms of the proposed standards.

One individual objected to the term "interstitial" for a type Of pore but others thought the term was acceptable.

b. Standards for descriptions of roots. Using the same size and abundance classes for roots as for gores seemed acceptable. It was suggested that if roots larger than 10 cm were present, their presence and an estimate of their volume should be recorded.

It was agreed that description of roots as "inped" or "exped" should be included in the standards.

If no roots or visible pores are present in a horizon, the standards should require an explicit statement to that effect.

Descriptions of concretions, nodules, accretions. one suggestion was to use Brewer's term "glaebules" for the features included in the definition of concretions in the present Manual.

The recommendation of the subcommittee to use the same size classes for the description of glaebules as are used for mottles seemed acceptable. The standard consistence classes would be applicable to descriptions of glaebules.

H. Report of the Subcommittee on Clay Films and Skeletans

The subcommittee unanimously supports the need for standards for the description of cutans*, including clay films and skeletans. We recognize that few specific guides are available to assist the field man to correctly identify them or to consistently record their important

---

* Cutan - A modification of the texture, structure, or fabric at natural surfaces in soil materials due to concentration of particular soil constituents or in situ modification of the plasma; cutans can be composed Of any of the component substances Of the soil material. (Brewer, 1964)

features. Soil scientists have developed local standards based on observations in their particular area. Such standards differ widely among states because the ranges in the features of the cutans in any one state are likely only a part of the total ranges in these features.

1. Soil fabric characteristics

Several kinds of soil fabric features need to be recognized and described. Clay films and skeletans are two of these. Other coatings or cutans have been recognized that do not have the definitive characteristics of either clay films or skeletans. The subcommittee feels that these need to be described. Failure of a given soil fabric to qualify 88 a clay film should not eliminate the need to recognize and describe the feature.

Clay films have been defined as "the assemblage of optically oriented clay (less than 0.002 mm) with included coarser particles, formed on the walls of interstice* in the soil and exhibiting abrupt internal and external boundaries." (Buol and Hole, 1961) Films known to consist mainly of optically oriented clay should be designated as clay films. Others should not be so designated. As one subcommittee member pointed out, "I don't know of a fool-proof way to know if what looks like a clay film is oriented clay except to go to the laboratory. We can reduce our errors by being stringent in our use of 'clay film' and/or by not claiming more than we can deliver when we identify clay films."

Brewer defines skeletans as skeleton grains adhering to the cutanic surface. Further, "skeleton grains of a soil ❑ *teri*l are individual grains which are relatively stable end not readily translocated, concentrated or reorganized by soil-forming processes; the:, include mineral grains and resistant siliceous and organic bodies larger than colloidal size."

The term skeletan has been growing in popularity but has not been consistently applied by all soil scientist*. It seems to have utility as a term to designate the "frosting" of uncoated mineral grains on peds or the interfingering of an albic horizon into an underlying argillic or natric horizon.

Other cutans are commonly recognized by soil scientists and appear to be important to our understanding of genesis of soils and in making interpretations. Some of these cutans are detected by differences in color between the outside of peds and the interior of peds. Such differences are evident when the surface of the ped is rubbed or the ped is crushed. Other cutans are "in situ modifications of the plasma due to differential forces such as shearing; they are not true coatings." Such cutans have been designated as stress cutans by Brewer. Examples are pressure faces, resulting from pressure against surrounding soil masses, coarse fragments, etc., and slickensides, a specific type of pressure face that exhibits striation* due to slippage of one ped across another. Some soil scientists have found cutans that appear to be "silt coats" as an illuvial rather than an eluvial feature.

2. Standardization of characteristics

Standardization of description requires standardization of the conditions under which the feature is observed. Moisture status, for example, is very important. Films of moisture reflect light and appear slick and smooth. Thus, they have some characteristics common to clay films and may be confused with them. To eliminate the possibility of confusion with moisture films, most subcommittee members who responded recommend that the soil be dry before clay films, skeletans and other features of the soil fabric are described. One noted that some thin clay films may be disrupted by the drying process and ❑ sy be overlooked in dry soil.

No firm agreement has been reached on the following proposed classes. These represent an attempt to reconcile the views of the subcommittee members who responded. Several members emphasized that the description of these features should be brief and should not represent an unreal claim to precision. Since distinctness is a result or reflection of several features such as color contrast and thickness and represents the degree of reliability of identification, thia feature was selected instead of thickness. Thickness of films is highly variable, even on a given surface of a ped and thickness of that portion that is optically oriented is often little more than a guess. One member argued for classes of frequency and classes of continuity, on the basis that the first has to do with the proportion of peds that have coatings or cutans and the second deals with the part of a given ped or other surface that is covered with a coating or has been modified in another way. He is probably correct. However, in the Interest of brevity, continuity classes are omitted in the following proposals.

Another proposal was that no reference to clay films or other such specific names of features be given in pedon descriptions, but that descriptive terms such as rough, shining, glossy, and wax-like be used. Inasmuch as the soil taxonomy uses clay films, slickensides, skeletans, etc., it seems advisable to use these in our descriptions whenever the features can be reliably identified. Cutans that cannot be identified should be described in appropriate descriptive terms.

3. Proposed standard classes and conventions for field description of cutans (clay films, skeletans and other)

Abundance

Few - on less than 10 percent of the peds or other natural surfaces examined.

Common - on 10 to 50 percent of the peds or other natural surfaces examined.

Many - on 50 to 100 percent of the peds or other natural surfaces examined.

Distinctness

Faint - The feature is thin (or thickness is indeterminable) or color contrast is weak; identification is uncertain.

Moderate - The feature is thick enough to clearly identify, or color contrast is strong or other distinguishing characteristics are evident; identification is reasonably certain.

Prominent - The feature is exceptionally well expressed; usually thicker than .l mm or color contrast is very strong; identification is certain.

Kind

clay film
skeletan
silt coating
lime coating
manganese coating
salt coating
organic coating
(If the kind of coating or other cutan is unknown, use the general term "coating" or some other descriptive term.)

Location

in root channels
on all faces of peds
on horizontal faces of peds
on vertical faces of peds
on mineral grains
on coarse fragments
on tops and/or sides of columns
(other locations if needed)

Examples

few moderate clay films on vertical faces of peds
many prominent skeletans on tops and sides of columns
many pressure faces on all faces of peds
many moderate clay films on mineral grains (This would amount to bridging if the clay films touch each other.)
common faint shiny coatings on faces of peds

We recognize that color is an important characteristic of cutans. This characteristic is commonly described in connection with the matrix color. For example, brown (10YR 5/3) silt loam, dark brown (10YR 7/3) moist, dark grayish brown (10YR 4/2) coating... If not recorded in this manner, color should be included in the description of cutans. Example: many moderate dark grayish brown (10YR 4/2) organic coatings on faces of peds.

J. Ellsworth Brown
Subcommittee Chairman

Proposed substitute for distinctness classes for cutans in subcommittee report dated 11-30-70, FJC 1/71

This proposal is based on two considerations: (a) definitions of classes should not confound degree of certainty of identification as to kind with thickness or distinctness of the feature, and (b) thickness of some coatings is of consequence and we should have conventions for expressing thickness.

Provide conventions for description of distinctness and thickness of cutans with the understanding that one or more of these may not be suitable or appropriate for the description of a particular feature. Descriptions of distinctness need to be coupled with statements of moisture condition because distinctness of cutans often changes with changes in moisture content. The conventions would be used where needed for adequate or complete descriptions of individual horizons.

a) Distinctness classes:

Faint - The combination of one or more of thickness and lack of color or texture contrast with adjacent matrix is such that the feature is evident only on close examination. Magnification of 10X commonly is required to determine presence and nature of the feature. Coatings usually are thin and of low color contrast to the adjacent matrix.

Distinct - The combination of one or more of thickness and color or texture contrast with adjacent matrix is such that the feature is clearly evident without magnification, although magnification or other tests may be needed to determine the nature of the feature. Coatings commonly are of medium thickness and low contrast to adjacent matrix or thin and of relatively high contrast to adjacent matrix.

Prominent - The combination of one or more of thickness and color and texture contrast with the adjacent matrix is such that the cutan or coating is a conspicuous feature of the morphology. Coatings commonly are medium or thick and have distinctly different color or texture, or both, than the adjacent matrix.

b) Thickness classes:

Thin - Coatings are so thin that very fine sand grains, if present, are readily apparent in the film and/or sand grains are thinly coated with clay and held together by weak bridges of clay; magnification is required to determine thickness; thickness commonly is less than approximately 0.1 mm.

Medium - Very fine sand grains, if present, are enveloped by the coating or their outlines are indistinct; broken edges of the coatings can be seen in cross section with a hand lens; if clay is in bridges between grains, broken bridges can readily be discerned with a hand lens; thickness commonly is between approximately 0.1 mm and 0.6 mm.

Thick - The edges of broken coatings are readily visible in cross section without magnification; coatings of clay or silt appear relatively smooth because fine sand grains, if present, are encompassed by the coating; coatings commonly are thicker than approximately 0.6 mm.

c) Where feasible and useful, thickness in millimeters should be described instead of using the standard thickness classes. Thus, coatings might be described, for examples, as "continuous prominent light gray silt coatings about 1 mm thick on coarse subangular blocky peds" or "many dark gray clay skins about 1 to 2 mm thick on very coarse prism faces and on horizontal partings."

Discussion of the report of the subcommittee on clay films and skeletans

The foregoing report of the subcommittee was not discussed during the regular sessions of the Conference at Charleston. Immediately following adjournment of the Conference some members assembled to discuss the report. The following notes pertain to that discussion.

a) It was evident from the subcommittee report and from the discussion of it that, although there is wide support of the need for standards for descriptions of clay films and other kinds of cutans, opinions concerning details of the standard8 for such descriptions vary widely. Most people thought standards should be provided for a) abundance or frequence or continuity or some combination of these, b) distinctness or thickness, or both, c) location with respect to other morphological features.

b) The discussion indicated fair support for the idea that standards should be provided for descriptions of several characteristics of coats or cutans with the understanding that one or more of them might not be applicable or useful for the description of a particular feature in a particular soil. The elements of the conventions would be used where applicable and needed for complete descriptions.

c) There was fair agreement that the conventions end standards should be for the description of cutans or coatsin general, not for a particular list of kinds that would be specified. The kinds of features would be illustrated, for examples: clay films, silt coats, sand coats, pressure faces, lime coats, manganese coats, coats, etc.

Members of Committee 3

J. Ellsworth Brown
F. J. Carlisle, Chairman
R. C. Carter
Arvad J. Cline
Marlin G. Cline
Raymond B. Daniels
J. A. DeMent
Raymond I. Dideriksen
Klaus W. Flach
Leland It. Gile
John W. Hawley
Geo. G. S. Holmgren
Ben I,. Matzek
J. E. McClelland
Arnold O. Ness
Wiley D. Nettleton
Oliver W. Rice
Samuel Rieger
Roy W. Simonson
David F. Slusher
Maurice Stout, Jr.
Dwight W. Swanson

Appendix I. Solum - A Discussion and a Proposal, Prepared by Ben L. Matzek

Solum is a handy term to represent a part of the soil or soil profile, although its meaning is vague. It is widely used, including appearances in publications and series descriptions. If continued, it will need to be reviewed and redefined. The concept that has evolved through the years has varied and is inadequately stated. This is seen in solum definitions set forth at different times beginning with that of Dr. Marbut in 1935. They are repeated entirely or partly in paragraphs that follow.

Dr. Marbut. Atlas of American Agriculture, 1935.

> "The true soil is usually designated as the solum and is usually separated into two parts, an upper part called horizon A, and a lover part called horizon B. The true soil may be defined as follows:
>
> > "The soil consists of the outer layer of the earth's crust, usually unconsolidated, ranging in thickness from a mere film to a maximum of somewhat more than 10 feet, which differs from the material beneath it, also usually unconsolidated, in color, structure, texture, physical constitution, chemical composition, geological characteristics, probably in chemical processes, in reaction, and in morphology."

Soils and Men, 1938.

> "The upper part of the soil profile, above the parent material, in which the processes of soil formation are taking place. In mature soils this includes the A and B horizons, end the character of the material may be, and usually is, greatly unlike the parent material beneath, Living roots and life processes are largely confined to the solum."

F. F. Riecken and Guy D. Smith, Soil Science, 1949.

> "The term 'solum', coined by Frosterus and introduced into this country by Marbut, hes come to be commonly accepted as that part of the profile in which parent material has been altered during soil formation."

The 7th Approximation, 1960.

> "The solum has been considered the 'genetic soil' that developed by soil building forces.... Solum is used here to include A and B horizons and, in addition, fragipans and home duripans. Solum, as used in this text, is not a synonym for soil, which often includes or even consists of C material."
>
> "Not included in the solum are accumulations of carbonates, sulfates, or more soluble salts, nor zones of cementation caused by silica under strongly alkaline conditions . . .."
>
> "Solum includes the following diagnostic horizons, defined later: all epipedons, agric, albic, argillic, natric, spodic oxic, and cambic horizons, fragipans, and duripans either requiring repeated alternating treatments with acid and alkali to soften or underlain by a spodic horizon."

Supplement to the Soil Survey Manual, 1962

> "The solum may be defined simply as the genetic soil developed by soil-building forces. In normal soils, the solum includes the A and B horizons, or the upper part of the soil profile above the parent materiel.
> "'Although the concept of solum is commonly understood by soil scientists, this definition is deceptively simple. Especially in some of the intrazonal soils, the actual sola are not easily determined; end in some soils their lover limits can be set arbitrarily, say at 6 feet or 2 meters, or et the lower limit of plant roots. Used with such soils the term 'solum' may need to be defined in relation to a particular soil."
>
> "The common Cca horizons of Chernozems . . . are not within the solum."
>
> In certain gleyed soils the A horizon rests on @eyed C material and "only the upper part belongs in the solum."

Important weaknesses in the statement by Dr. Marbut are that most sola have both A and B horizons and all are underlain by the parent material.

In Soils and Men, "mature" soils with A and B horizons are emphasized, though one may conclude from the first sentence that the combination of A and B horizons is not a requirement. This sentence in the definition indicates, however, that the solum is underlain by the parent material. There is also the suggestion that the solum corresponds with the zone of living organisms.

The concept presented by Riecken and Smith is good but should be expanded to enumerate items that it presumably comprises. One is the inclusion of all genetic soil horizons, however weakly they express the forces of soil formation. Another is to specifically include contiguous sequums. A third is to exclude deeply buried Boils under a soil layer that is not pedogenic.

The 7th Approximation defines the solum as the genetic Boil, except for certain horizons thet may show the effects of soil formation. It restricts the solum to A and B horizons with or without the fragipan or some duripans. Excluded soil horizons that may be genetic are those with accumulations of carbonates, sulfates, or more soluble salts. Examples of such horizons are layers of carbonate accumulation under Mollisols. Same such layers show enough alteration of the parent material to be Bca horizons,

The 1962 Supplement makes the same exclusions as the 7th Approximation end suggests arbitrary maximum depths of 2 meters or the bottom of the root zone, if the solum is difficult to determine. It leaves a question as to whether or not the solum must have both A and B horizons. As a consequence, interpretations differ. Many require both horizons even though the second paragraph of the definition and the reference to the A horizon of certain gleyed soils suggest that both are not necessary.

The definition of the solum should cover items enumerated in the sentence that follow. It should (1) include all genetic soil horizons, even faint or prominent layers that show weak effects of soil formation, (2) exclude parent material, (3) not be confined to the zone of major biological activity, (4) not be limited to minimum or maximum thicknesses, (5) include contiguous vertical sequums, and (6) exclude buried genetic soil horizons separated from upper horizons by soil layers that are not pedogenic.

An attempt was made to incorporate these items into the statement of the concept in the paragraphs that follow.

> The solum comprises genetic soil horizons in the outer part of the earth's crust, that are vertically contiguous and whose materials have been altered from the parent material by soil formation forces. The horizons included are those qualifying for A, E, and B, and pedogenic parts of' fragipans, cemented layers, and layers of accumulations of carbonates or more soluble salts. The number of horizons varies from one to several in one or more sequums. Vertical sequences of the solum are unbroken by layers that are not pedogenic. Sequences below such layers are not a part of the solum.
>
> The solum varies in combinations as well as numbers of horizons. A thin A horizon overlying materials that are not pedogenic constitutes a solum. The same is true where there is a sequence of A, E, and B horizons or where there is an A horizon, a B horizon, and 8 subjacent duripan. In certain soils with fragipans the solum includes the bisequum of horizons above and within the pan. On the other hand, deeply buried genetic horizons, which are separated from upper horizons are not a part of the solum.
>
> Solum and soil are not synonymous. Soil includes parent material and is confined largely to the zone of major biological activity. Where the solum is deep or includes the fragipan or cemented layers it extends beyond this zone.

Appendix II. Moisture Status Definitions Proposed for Soil Consistence Evaluations by the 1968 Western Regional Committee on Soil Structure and Fabric. es Modified by the 1969 National Committee on Criteria for Series and Phases

A. Dry (used for loose, soft end hard consistence evaluations): Literally air dried for severe.1 days or the equivalent field condition.

B. Moist (used for loose, friable, and firm consistence evaluations): Moist enough that material will show coherence with slight pressure but not so moist that it will show plasticity or free water surfaces (sandy materials may be loose and not show coherence).

C. Wet (used for plasticity end stickiness evaluations, with no distinctions es to structure or structureless):

1C. For plasticity: Yet enough so that after thorough kneading it will form a wire but not so wet that it will show properties of 2C below.

2C. For stickiness: Wet enough so that after thorough kneading it will exhibit maximum stickiness, i.e., approximately that moisture content et which the soil will just show free water films when sharply jarred.

Appendix III. Excerpts from W. D. Nettleton's Memorandum 10-28-70 to Subcommittee on Soil Structure end Consistence

We have developed some standards for moist consistence classes. our data show that the classes give" in the Manual need modification. As now defined the first three classes have overlapping ranges. Unconfined compressive strengths of the classes loose, very friable, and friable are between 0 end 1.2 kg/cm^2 (see table 1, attached). Since clear distinction has not bee" possible between the two friable classes I suggest we combine them to give the following classes:

Class	""confined compressive strength (kg/cm^2) of soil clods equilibrated et 1/3 ber tension	
	Lower limit	Upper limit
0 - Loose	0	0.5
1 - Friable	0.6	3.0
2 - Firm	0.6	5.0
3 - Very firm	5.1	20
4 - Extremely firm	21	404+

The friable class would still overlap the firm class in terms of strength, but the two classes can be separated on basis of the kind of deformation. Firm materials undergo plastic deformation, friable materials are somewhat brittle. The class limits have been modified to fit the results reported by Taylor and Bruce, 1968 ("Effects of soil strength on root growth and crop yield in the Southern United States," 9th International Congress of Soil Science Transactions 1: 803-811). Their results and papers cited by them show that penetrometer resistances of less the." about 2.5 kg/cm^2 do not restrict growth of roots, resistances of 5 kg/cm^2 drop root penetration to about 60 percent, resistances Of 10 kg/cm^2 to 35 percent, and resistances of 22 kg/cm^2 stopped root growth entirely. Their results argue for more breaks in the upper two classes, but do not support further breaks in the lower classes.

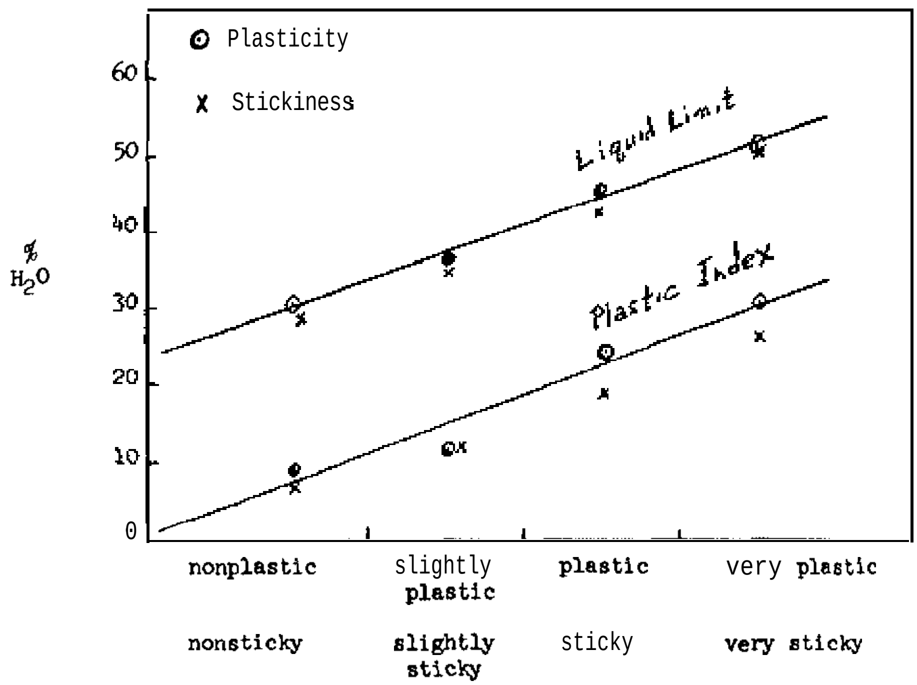
Unconfined compressive strength could also serve es a suitable standard for dry consistence classes. *The* standards proposed below are based on the attached data (see table 1).

Dry consistence class	Unconfined compressive strength (kg/cm^2)	
	Lower limit	Upper limit
0 - Soft	0	1.5
1 - Slightly herd	1.6	4.0
2 - Hard	4.1	12
3 - Very hard	13	40
4 - Extremely hard	41	150+

The operational definitions given in the Manual for classes of dry consistence seem to fit these classes defined in terms of unconfined compressive strengths.

Consistence of the soil when wet is described by operational definitions. Thinking that standards are needed for vet consistence also, I compiled the data we have for field consistence and Atterberg limits. The data are from the Western States, Puerto Rico, and Hawaii. The figure below gives the relationship of stickiness and plasticity as described in the field and liquid limit and the plastic index as measured in the laboratory. Though there is a lot of variability within each class of consistence, the average relationship looks suitable for choosing values for standards. Also the classes of stickiness and the Classes Of plasticity correspond very closely, i.e., nonsticky materiels are also nonplastic. slightly sticky materials are slightly plastic, and so on.

Field description of consistence of soils
when vet vs. Atterberg limits



Based on the data I chose the following limits for consistence classes.

Consistence class, from field description	Class limits based on liquid limits
nonsticky, nonplastic	< 35% H_2O
slightly sticky, slightly plastic	36-42% H_2O
sticky, plastic	43-49% H_2O
very sticky, very plastic	> 50% H_2O

Taking these class limits I examined the data to find how many observations fell within the class limits for each class. These results are given below.

Consistence class, from field description	Number in class	Number correct (%)
		78
slightlyksticky	100	18
		17
veryksticky	120	62
nonplastic	62	79
slightly plastic	138	14
plastic	95	15
very plastic	48	60

The extremes apparently are easy to describe, but samples are difficult to place correctly in the intermediate classes we now have. Some improvement can be gained by combining the Intermediate classes. The result of this combination follows.

Consistence class, from field description, intermediate classes were combined	Class limits based on liquid limits
nonsticky, nonplastic	< 35% H_2O
sticky, plastic	36-49% H_2O
very sticky, very plastic	> 50% H_2O

Using three classes in place of four equalizes the class intervals. It also increases the percentage of correct descriptions.

Consistence class, from field description, intermediate classes were combined	Number in class	Number correct (%
nonsticky	100	78
sticky	293	30
very sticky	45	62
nonplastic	62	79
plastic	233	27
very plastic	48	60

Perhaps the other committee members can go through the data they have and make some revision of the class limits I set up for study. It seems certain we have too many classes of wet consistence. Dropping back to three classes would increase our score and still give a reasonable separation from the standpoint of use Of the data.

Liquid limit is a crude shear test. Hence is influenced among other things by both texture and mineralogy. Texture could be a useful guide to wet consistence in areas where mineralogy is relatively uniform. Field capacity or /3 bar water has been suggested here as another guide to vet consistence. I think our subcommittee should study the date available, select a suitable standard, set up class limits, and recommend that they be made part of the new Manual. We can't expect any improvement in soil descriptions unless universal standards are used.

Table 1. Comparison of field and laboratory measurement of soil consistence

Consistence class	Number of samples	Unconfined compressive strength*			
		Arithmetic mean	Geometric mean	Median	Range
Moist soil					
very friable	5	1.0	1.0	1.1	0.6-1.2
friable	22	1.2	1.1	1.2	0.4-2.6
firm	24	1.7	1.4	1.1	0.6-6.2
very firm	6	11.2	8.5	8.2	0.6-20.9
extremely firm	10	94.4	36.2	41.1	5.4-404.4
Dry soil					
slightly bard	30	3.9	2.3	2.0	0.3-14.6
hard	38	11.1	6.6	7.4	0.5-44.9
very hard	23	31.0	20.0	25.7	1.4-99.0
extremely hard	11	162.9	73.0	71.0	16.1-839.0

*Measurements were made on one block from each sample (horizon). Each block was sawed to a length at least twice the width of its base.

A. Objectives:

After the 1969 National Technical Work Planning Conference, the committees on "Criteria for soil series and phases" and "Application of the new soil classification system" were combined under the present committee name. It was recommended that both committees be continued to consider reports of regional committees and other problems that may become apparent as the new system of classification continued to be applied. It should be noted that a new committee, "Standards for descriptions of soils," has expanded upon some of the suggestions incorporated in the old committee on "Criteria for soil series and phases".

B. Regional Committee Reports:

The North Central and Northeast regions each prepared committee reports concerned with criteria for series and phases. The Western, Southern, and North Central regions prepared committee reports concerned with the application of the new classification system. The Northeast Committee dealt with subject matter appropriate for the new committee on "Standards for descriptions of soils" and the report was referred to this committee.

The North Central Committee on "Criteria for series, types, and phases" discussed series and phases and what should be criteria for each. As a starting point, they proposed:

1. Series criteria should include morphological characteristics related to and important to both genesis and behaviour;

2. Phase criteria should include soil and site characteristics important to soil behaviour.

They consider there is a definite need to expand these definitions.

The committee also proposed that moderately deep families should be recognized for soil series that have lithic and paralithic contacts between depths of 20 and 40 inches below the soil surface.

The committee "questions and proliferation of taxadjuncts in some recent correlations on the basis that these additional units unnecessarily complicate classification and subsequent interpretations.".

The North Central Committee on "Soil correlation principles, procedures, and rules and application of the new classification system" made no specific recommendations. They consider that drainage criteria for wet soils should be studied in conjunction with water table regimes to improve the classification of these soils. They discussed whether Albalfs (similar to Albolls with respect to wetness) should be defined. The Albalfs would include the present Albaqualfs. They suggested A&B and B&A horizons shouldn't be called just "B" horizons, i.e. the whole horizon would be a cambic horizon if it did not meet the requirements of an argillic horizon.

The Western Committee on the "Application of the new system of soil classification" added some additional criteria used to differentiate series within the same family* These are:

In fine families, silt sand ratios
Size of coarse fragments--less than 10 inches and more than 10 inches
Calcareous vs. noncalcareous
Kind of underlying rock
Lamellae in B2t horizon
Thickness of horizons
Diagnostic horizons when not recognized at higher levels--calcic, gypsic, cambic, albic
Silica pans
Clay content in fine families--less than 50 percent and more than 50 percent
Glacial till vs. other mixed unconsolidated material
Hard fragments and soft fragments.

*Additional to those reported in 1969 by the national committee on "Criteria for soil series and phases," Appendix III.

The Western Committee discussed family nomenclature for use in naming mapping units at the family level. Reports using family names taken from the name of a well known series in each family and using the complete family name such as "Ashy over loamy-skeletal, mixed, frigid, Typic Vitrandepts" have been working "quite well". No attempt has been made to devise and test a systematic nomenclature to identify families.

The Southern Regional Committee on the "Application of the new classification system" deliberated about lateral and vertical dimensions of pedons, buried soils, and the control section for soil series. They suggested that a buried B horizon should not be recognized unless a buried A horizon immediately above it can be recognized. They would like the control section for soil series to extend from 25 cm to a lithic or paralithic contact shallower than 2 m, or to 2 m where the regolith is at least this deep and to 3 m for Grossarenic subgroups or to the upper boundary of a lithic or a paralithic contact shallower than 3 m.

C. Discussion of regional committee reports:

There was not a great deal of controversy generated by the regional reports. The use of taxadjuncts will be discussed later in this report. There was no support for the use of family names except where the family name is that of a series within the family. A recommendation about the recognition of buried soils follows:

1. Buried soils will not be recognized in the soil classification system at a category above that of series unless:

   a. the buried soil includes at least one diagnostic horizon other than an ochric epipedon;

   b. the organic carbon of the buried soil is of Holocene age, i.e. less than 11,000 years BP;*

   c. the organic matter content of the soil having buried diagnostic horizons must decrease irregularly with depth or the organic carbon content in the upper subhorizon of the buried soil must be above 0.2 percent.

   *Identification of soils older than Holocene age is assumed to be imprecise.

For soils with sola together with any subjacent Cca horizons that have lower boundaries that extend below 1 m, the series control section extends to the lower boundary or to 2 m whichever is shallower. The majority of the committee are satisfied with this definition of the series control section. They do not want to distinguish series on the basis of the character of the material between 1 and 2 m deep unless there is evidence of developed horizons extending deeper than 1 m.

There is some inconsistence with respect to Grossarenic subgroups. These subgroups have soils with textures finer than sandy at depths between 1 and 2 m. Presumably the upper boundary of the argillic horizon approximately coincides with these less sandy textures. Thus the upper boundary of the control section for particle-size class modifiers in families of Grossarenic subgroups could range from 1 m to 2 m and the control section could extend 50 cm below these depths or to 1.5 m or 2.5 m. The maximum depth below which the series control section extends is 2 m.

Several members questioned whether salinity and the nature of the contributing rock could be used as series criteria as was indicated in the 1969 national committee report on "Criteria for series and phases". In relatively small amounts salinity usually is used as a phase criterion but where large quantities are present but not enough to change the classification, use of another series could be justified. The national report did not imply that there would not be other accessory characteristics that may be sufficient in themselves to justify another series.

The use of the nature of the contributing rock as a series criterion can be questioned. Probably clay mineralogy, nature of the boundary at the contact, and other characteristics would also vary. Rocks such as serpentine usually give rise to infertile soils but the mineralogy differs somewhat from the more fertile soils formed from basalt or andesite.

D. Additional subjects included in the committee deliberations:

1. Conventions for naming mapping units have been altered slightly in the revision of the Manual. The following is quoted from pages 12 & 13 of Soils Memo 66:

"Mapping units set apart in field work are to be named as phases of soil series, including soil types considered as one kind of phase, provided they meet the requirements spelled out below under Alternative I or Alternative II.

"Alternative I. three-fourths or more of the polypedons fit within the phase of the series that provides the name for the mapping unit or fit in closely similar phases* of the same series or of other series in closely similar families of the same subgroup, in parallel families of like subgroups, or in other families closely similar in behavior. The most extensive kind of soil must fall within the range of the phase providing the name for the mapping unit. As a rule, that kind constitutes more than half. The most extensive soil, however, may constitute as little as 35 percent of the mapping unit if 15 percent or more consists of a taxadjunct to the series. Each of the inclusions of soils of closely similar series may constitute as much as 25 percent of the mapping unit but their aggregate proportion must not exceed 50 percent. Minor proportions of strongly contrasting soils are also allowed as inclusions but none of them individually may constitute more than 10 percent and their aggregate proportion may not exceed 15 percent."

---

*Closely similar phases may belong to the same series, to other series in parallel families of like subgroups, to other series in closely similar families, or to taxadjuncts.

"Alternative II. Three-fourths or more of the polypedons fit within a taxadjunct to the series that provides the name for the mapping unit or fit in other series in closely similar families of the same subgroup, in parallel families of like subgroups, or in other families closely similar in behavior, but the series providing the name does not occur in the survey area. The proportions of the most extensive kind of soil and of the similar and contrasting inclusions are the same as under Alternative I.

"Alternative I covers the common situation that will be met in correlating soils of individual survey areas. Follow that alternative as usual practice.

"Follow Alternative II only if the most extensive kind of soil in a mapping unit is a taxadjunct and the series providing the name is not represented in a survey area. For example, the most extensive kind of soil might fit a series in all respects except temperature. This is true of some soils in Maryland, just east of Washington, D. C. They fit series classified in thermic families except that temperatures are believed to be slightly below the mesic-thermic limit. Furthermore, the total acreage is small. A limited acreage in Prince Georges County, Maryland has therefore been correlated with the Hyde series, which is classified in a thermic family of Typic Umbraquults. The soils in question are being handled as taxadjuncts to the Hyde series."

In the revision of the Manual guides to mapping inclusions are discussed with respect to individual delineations and to the total area of these individual delineations that are included in a single mapping unit in a soil survey area.

"Mapping units in terms of single taxa.** Within any single delineation the following limits apply to detailed soil mapping:

a. At least 75 percent of the delineation should consist of the named soil and other similar polypedons.

b. Similar polypedons, including taxadjuncts, may constitute from 0 to 100 percent of a given delineated area but with these restrictions:

   (1) Similar polypedons are not represented by named mapping units in the legend may constitute from 0 to 100 percent of a given delineated area.

   (2) Similar polypedons represented by named mapping units in the legend may not constitute more than 50 percent of a given delineated area.

c. Dissimilar polypedons represented by named mapping units in the legend may constitute not more than 25 percent of any given delineated area, with the following restrictions:

   (1) Dissimilar polypedons less limiting for the purposes of the survey than the named soil may constitute not more than 25 percent of a given delineated area.

**Including phases of single taxa. A phase is a segment of any class of any category differentiated from the remainder of the class on the basis of criteria significant for use, management, or behavior of the soil.

(2) Dissimilar polypedons more limiting for the purposes of the survey than the named soil may not constitute more than 15 percent of a given delineated area, exclusive of the area represented by defined spot symbols.

d. Dissimilar polypedons in areas of mappable size but not represented by named mapping units in the legend may constitute 100 percent of delineated areas if they are less limiting than the named soil. (Those more limiting are mapped under the symbol of other taxa that would satisfy this relationship.)" (Most of these areas are the result of the correlation of small units that are too inextensive to retain.)

These criteria "specify that no more than 15 percent of any given delineation named in terms of a single taxon should have greatly more restricting limitations for the purposes of the survey than the named soil." "In many landscapes, the soil scientist should strive for less than 5 percent. The 15 percent limit is also used as the dividing point between units named in terms of a single taxon and units named in terms of two or more associated taxa, called complexes."

"The criteria also take into account that a taxadjunct may be present in a survey area that does not include polypedons of the soil series whose name it bears. In such a case not only the individual delineations but also the aggregate mapping unit may consist almost wholly of 'similar polypedons' that are members of the taxadjunct.

"The proportions of permissible inclusions in a <u>mapping unit</u>, as the aggregate of its individual delineated areas, are quite different from those for individual delineations. As an approximation, the following may be used as guides:

1. At least 75% of the aggregate area of a mapping unit should consist of the named soil and its taxadjuncts, either individually or in combination.

2. The aggregate area of all inclusions other than taxadjuncts should be less than 25% of the total area of the mapping unit.

   a. Similar polypedons other than taxadjuncts plus dissimilar polypedons of lesser limitations than the named taxon may account for all of the proportionate area of inclusions.

   b. Dissimilar polypedons of greater limitations than the named taxon should constitute less than 5% of the total area of the mapping unit, exclusive of the area represented by defined spot symbols.

"The criteria presented are intended to apply to medium-intensity detailed soil surveys at a scale of approximately 1:20,000 with mapping units named in terms of soil series, soil variants, or their phases. For similar scale and intensity of survey, mapping units named in terms of taxa of higher categories would require similar limits in practice."

"<u>Mapping units named in terms of two or more taxa</u>. If the patterns of two or more associated dissimilar polypedons and the sizes of their areas prohibit separation at the scale of mapping, they must, of course, be included in the same delineated area. The preceding section has specified that a mapping unit of a detailed soil survey may be named in terms of a single taxon if

a) Inclusions similar to the named soil are as much as 50% of delineated areas.

b) Inclusions dissimilar to and less limiting than the named soil are less than 25% of delineated areas.

c) Inclusions dissimilar to and more limiting than the named soil are less than 15% of delineated areas.

"It follows, therefore, that names of two taxa are not used if the associated polypedons are 'similar'. The mapping unit is named in terms of whichever of the associated similar taxa is most extensive within individual delineations. Or conversely, the field soil scientist identifies the areas he outlines on the soil map under the symbol of whichever of the 'similar' taxa in his legend is most extensive in the delineation.

"If 'inclusions' of dissimilar polypedons in delineated areas of detailed soil surveys exceed the specified limits, however, the names of two or three taxa are used as reference terms in the name of the mapping unit. The name of the most extensive taxon is the first term. The name of a second taxon is added to it when the aggregate of polypedons dissimilar with respect to the most extensive soil exceeds the limits prescribed for use of the name of a single taxon-25 percent of the dissimilar polypedons are less limiting and 15 percent if they are more limiting for soil behavior than the dominant soil. The two terms are separated by a hyphen, as "Corning-Redding". Such a mapping unit is called a soil complex."

2. Rules are needed for use of the many kinds of inclusions we have in mapping units. There are phases of similar and dissimilar named and unnamed series and variants any of which may or may not occur in the publication area. Then there are phases of taxadjuncts which are more similar than some phases of similar series. In addition there may be degrees of similarity of phases within mapping units of single series. Technical names for these are appropriate in soils handbooks, scientific papers, and the portion of the manuscript for soil surveys that includes soil genesis and classification. Use of all of this nomenclature may cause some confusion for our nontechnical reader of manuscripts for soil surveys.

   It is proposed that the technical description of the typical pedon for the soil survey area together with its range in characteristics should be confined to the range in properties of the named series that have been observed in the area.

   Mapping unit descriptions will refer to inclusions that are phases of series, variants and taxadjuncts and that are described in the manuscript, by their correlated names. Inclusions of other phases will be identified by their outstanding characteristics even though the phases are named in other soil survey areas. This is the procedure being followed at the present time although Soils Memo 66 did not establish different rules for use in writing for technical and non-technical readers.

   There is a technical problem that arises when all of the soils in a unit belong to a taxadjunct of the named series and named series is not mapped in the survey area. It is not possible to follow the above paragraph literally. The section of the report manuscript dealing with soil classification should point out that the described pedon is a taxadjunct although in most respects the described pedon is within the range of characteristics of the named series.

3. Taxadjuncts were introduced by Soils Memo 66. A quote from the revision to the "Manual" that is consistent with the memo follows:

   > "The 800-hectare limit for recognition of a new soil series instead of a variant is not pertinent to the case of taxadjuncts. Unless there are compelling reasons to recognize a soil series for purposes concerned with the taxonomic system itself such fragments of classes should be included in mapping units as taxadjuncts of established soil series even though their total extent were large.
   >
   > "It may be found in other soil survey project areas that polypedons that have been taxadjuncts in another landscape are associated with others that provide the full range of a legitimate soil series. When this is known, the appropriate soil series should be defined and named, and its range would include the former taxadjuncts."

   The committee is not unanimously in support of this statement nor is the North Central region.

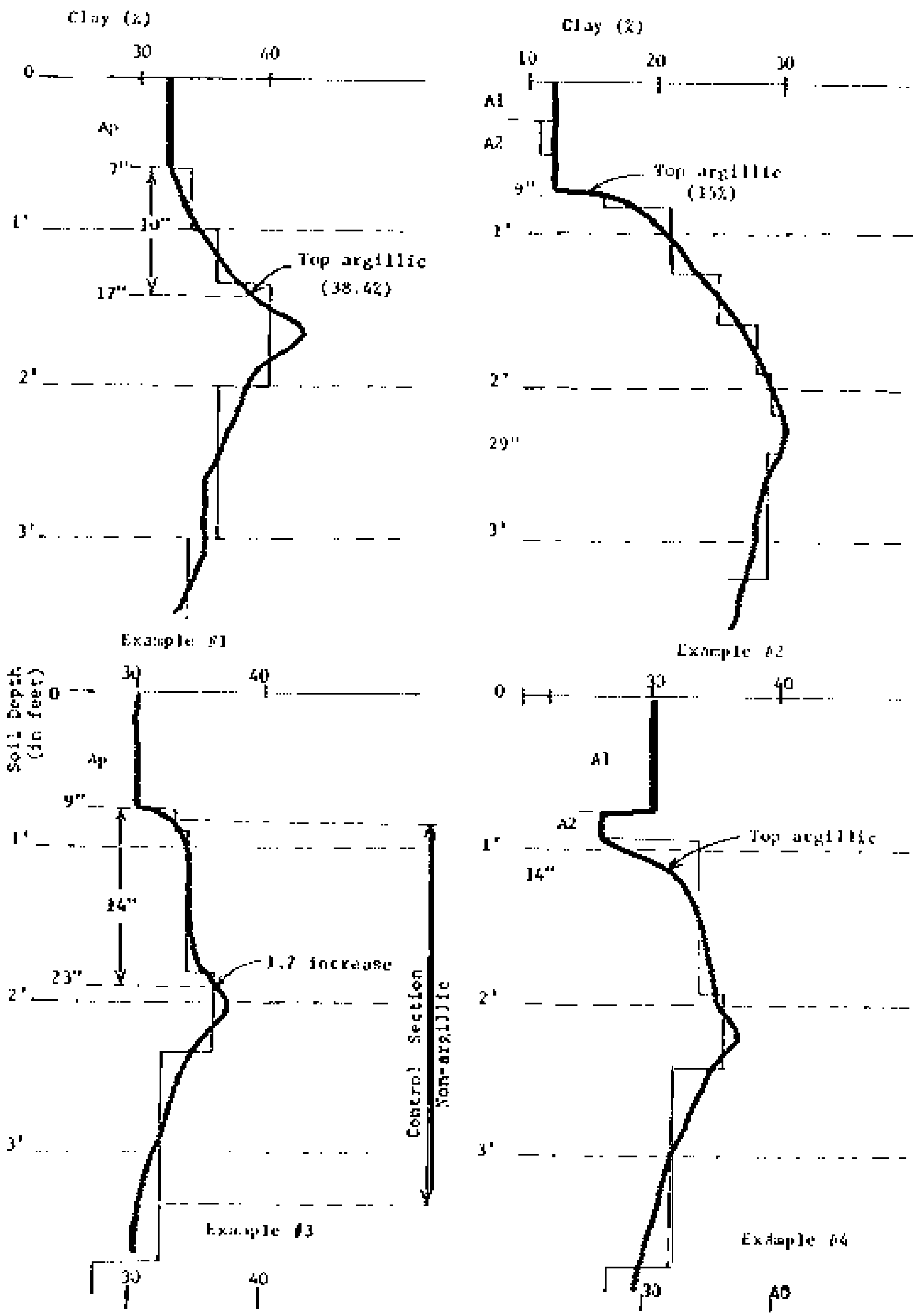
   Taxadjuncts are largely accidents in a sense that the series they belong to have not been recognized to date. If the series had been recognized then the separation would have to be made, because, by definition, taxadjuncts are not parts of named series. Taxadjuncts that are more extensive than 800 hectares (2000 acres) should be used only where it is quite well established that the series is very local in occurrence. When the whole country has been mapped and is being recorrelated, the concept will be more useful to eliminate series of small extent and low contrast with existing series.

4. Application of the criteria that are used to establish the presence or absence of an argillic horizon in most soils is not too difficult. Soils that have relatively thick sola and gradual or diffuse horizon boundaries or that have weakly expressed argillic horizons or that are marginal with respect to thickness limits, give rise to most of the problems. The definition of the control section for texture for a pedon with an argillic horizon makes it necessary to determine consistently the location of the upper boundary if this boundary is less than 1 m below the soil surface (except it may be deeper for Grossarenic subgroups). Where the lower boundary of the argillic horizon is less than 50 cm below the upper boundary, its exact location is also important.

   By definition an argillic horizon usually must contain at least 1.2 times as much clay as the overlying eluvial horizon except that there must be at least 3 percent more clay with soils having less than 15 percent clay in the eluvial horizon and at least 8 percent more clay with soils having 40 or more percent clay. In addition this clay increase must be met within a vertical distance of 30 cm. The depth to the upper boundary and the thickness of the argillic horizon must also be within defined limits. Except for soils in Cryic great groups and subgroups the texture of the Ap horizon is assumed to be uniform. If the soil has no Ap horizon it is assumed that the upper 18 cm are mixed and are of uniform texture. Thus soils with or without Ap horizons are classified the same although some judgement will be required where the depth of the Ap is much greater than 18 cm.

Figure 1 shows examples of the distribution of clay with depth in 4 pedons. The smoothed curves should be used to determine the position of the upper boundary of the argillic horizon. The boundary between the eluvial and illuvial horizons was not abrupt in any of these examples and was at least half the thickness of the underlying horizon. Where an A2 horizon abruptly underlies an Ap or A1 horizon or an A horizon (not Ap) abruptly overlies a B2t horizon it is assumed that the change in clay content is also abrupt. Example 4 illustrates an A1 overlying an A2 with an abrupt boundary. If the A2 horizon had had an abrupt boundary with the top of the B2t horizon the graph would more nearly approximate the unsmoothed graph. (The latter is shown to illustrate the thicknesses of the horizons that were sampled.)

Figure 1. -- Four Examples Showing Relationship Between Clay Content and Soil Depth.



Thin argillic horizons are characteristic of Aridisols and the drier Mollisols and Alfisols. Many of these soils are formed in calcareous parent materials and the argillic horizon rests abruptly on a Cca horizon. In these the thickness of the argillic horizon is readily apparent. In other instances the argillic horizon rests on a calcareous C horizon. But where the parent materials are noncalcareous it is considered the morphology will be the most reliable guide. The lower boundary of the argillic horizon should be the depth at which the properties of the argillic horizon are indistinct. Where the argillic horizon is marginal at best this boundary will probably be the boundary between the B2 and B3 horizons. In the latter instance the B2 and B3 horizons have about the same composition so that the exact thickness of the argillic horizon does not need to be measured very precisely.

Where A2 horizons tongue or interfinger into B2t horizons, thick intermixed horizons may be present. The upper boundary of the argillic horizon is the upper boundary of the B&A horizon providing the clay increase is large enough, i.e. the boundary is the point where the B2t portion predominates. The average texture of the entire horizon is used, not just the texture of the B2t portion.

5. The committee considered the subject of the names of taxa that are used in the names of mapping units of detailed surveys. It was agreed:

   a. The name of any taxon may be used in the name of a mapping unit providing the inclusions are within the limits described in D.1. Thus a unit could be named Aquic Haplorthods in a sandy, mixed, frigid family or loamy Fluvents, etc.

   b. The name should be that of a taxon of the lowest category that applies, i.e. series if appropriate; family if 2 series of the same family are included; etc.

   c. It was proposed that the "type" texture designation could be dropped from names of taxa, particularly where mono-type series are involved. The committee (1 for, 4 against) did not support this proposal.

   d. The entire defined range of each taxon may or may not be present in each delineation or in all of the delineations of that taxon in the survey area. This is consistent with present usage. The range in characteristics of the typical profile for a survey area usually is less inclusive than that of the official description.

   e. It is proposed that "type" should be retained for surface-soil texture phases. Its usage would apply to the average texture of the upper 7 inches. This is in accord with present usage except it is considered 6 inches is a more appropriate average depth of cultivation. The Manual and Soil Taxonomy may as well use the same arbitrary depths. To the committee's knowledge, the soil type was dropped only as a category in the system of soil classification.

   f. Surface phases should be permitted for use primarily in range lands. Use of these phases would be restricted to the upper few inches (not over 4), but the type designation would still apply to the upper 7 (6) inches after mixing. Thus Alpha loam, sandy surface, sloping would be a permissable name providing differences in use and management between this unit and Alpha loam, sloping can be demonstrated.

   g. The committee agrees that lack of a phase designation (other than the type) does not imply that a phase name could not be appended. The descriptive legend, not the name, provides the answer. But this should be stated in the "Manual".

E. Recommendations have been included in the report about:

1. Buried soils;

2. Inclusions in individual delineations and mapping units;

3. Rules for writing mapping unit descriptions in manuscripts for soil surveys;

4 Limitations in the use of taxadjuncts;

5 Application of criteria for the argillic horizon;

6. Names of taxa.

F. The committee recommends that it should be continued to discuss regional committee reports and problems in the application of the system of soil classification. In particular the next report should have specific recommendations about the use of the depth of the water table to drainage classes.

G. The report was accepted by the conference.

Committee members

J. E. McClelland, Chairman	J. V. Drew	Roy W. Simonson
H. J. Byrd	L. D. Giese	Guy D. Smith
M. G. Cline	C. H. Holzhey	R. I. Turner
J. R. Coover	J. D. Rourke	

Other contributors

R. B. Grossman
Warren C. Lynn
W. E. McKinzie

Discussion

Both Drs. Flach and Arkley questioned the choice of 11,000 years in item C1b page 2. Holocene is equal to post-pleistocene or recent times and a range of 10,000 ± 2,000 years would be more exact. ("It is assumed that the climate has changed very little since the close of the Pleistocene era.--chairman.)

Dr. Kellogg was concerned with the implication that the portion of the soil deeper than 1 m was being neglected in most deep soils. The chairman explained that while this is correct with respect to series distinctions for soils without developed horizons extending below 1 m, where significant, the characteristics below 1 m are used as phase distinctions. (Some changes in wording were made in the text to clarify the point Dr. Kellogg raised.)

There was considerable discussion about the nature of the contributing rock as a series criterion. In the 1969 report of the committee on series and phases, contributing rock was stated as being a series criterion. Actually this was a summary statement and its meaning was intended to include the relative ease of weathering of the rock, the fracture characteristics, the nature of the contact with the overlying soils, fertility of the soils associated with the rock, etc. These points were brought out by the chairman in answer to a query by Dr. Kellogg.

Dr. Fanning pointed out that the Piedmont area is underlain by hard rock and the coastal plains, by unconsolidated sediments. These differences are important.

Mr. Olson pointed out that fracture planes in rocks enabled many trees to survive in shallow soils. The nature of the contact is also important.

Mr. Coover commented that soil properties should be used to characterize soils.

Some modifications in the preliminary report were suggested by Dr. Cline. These consist of the elimination of "taxadjuncts" from some statements in item D1a because "similar soils" includes taxadjuncts.

Item D1b does not prohibit any one delineation from having 100 percent inclusions or unnamed components. As Dr. Kellogg pointed out, the extremes can be defined and it can be explained that the dominant soil has intermediate properties.

Dr. Cline explained to Ray Didericksen that inclusions in mapping units will be discussed in the section of the Manual under legends rather than mapping. There should be a cross-reference with soil correlation.

Dr. Cline pointed out that the 25 percent value (D1c) for inclusions of dissimilar pedons could possibly be raised to 35 percent. Ray Didericksen mentioned that this was a judgement fact with which Dr. Kellogg agreed. The Manual will point out that the 25 percent figure is an approximate value that is to be used as a guide.

With respect to Item B3 Dr. Bartelli mentioned that most taxadjuncts vary only slightly in the degree of difference of a property from the typical unit. In general they are two kinds. Some taxadjuncts vary in a property that can be measured quite accurately such as mineralogy, particle size distribution, or base saturation. Other taxadjuncts vary in rather ephemeral characteristics such as soil temperature or moisture regimes.

Dr. Cline suggests that minor differences in mineralogy should be overlooked if they are not significant to the use and management of the soils.

Dr. Carlisle pointed out that the errors of observation of the soil scientists making the soil survey must be considered in the mapping of taxadjuncts and the precision that can be maintained in identifying them.

Mr. Coover pointed out that minor adjustments in the permissible range in properties will eliminate the need for many taxadjuncts.

Mr. Turner pointed out the adjustment in the range in characteristics of soil series is limited by other class limits.

With regard to item D5c Dr. Cline believes we should not require the use of "type" in mapping unit names. He suggests type might be based more appropriately on the texture of the upper 10 inches for deep soils and the upper 6 inches for Cryic and shallow soils. (The 10 inches applies to the portion not covered in the control section.)

(The chairman believes that the upper 10 inches of soils that are at least 20 inches deep would be easier to apply. For Cryic soils and Lithic subgroups 6 inches is recommended.)

Dr. Bartelli believes that type should only be used in the phase name where type is significant to use and management. For example--Ruston, 2 to 6 percent slopes could be a mapping unit name where textures are uniform for the series in a survey area.

Dr. Cline suggested the use of Ruston series, 2 to 6 percent slopes.

Mr. Young says the use of "series" would create confusion and he suggests the use of "unit", i.e Ruston unit, 2 to 6 percent slopes.

In Item D5f Dr. Cline would prefer "cover" in the name in the example, i.e. alpha loam, sandy cover.

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service

1971 National Technical Work-Planning Conference
of the Cooperative Soil Survey
January 25-28, 1971, Charleston, South Carolina

Committee 5 - Engineering Applications and
Interpretations of Soil Surveys

A. Objectives of the National Committee

1. Receive and review proposals made by regional committees.

2. Test and evaluate these proposals for the improvement of soil survey interpretations.

B. Copies of the regional reports were sent to committee members for review and comment. In addition, committee members were asked to comment on specific questions asked by the chairman.

C. Regional Reports

1. Report of the North Central Region

A survey of users of soil interpretations in a small part of the region was discussed. The guides for making interpretations are needed and the consensus favored development of nationwide uniform criteria. The single-sheet interpretations were discussed.

Recommendations to the National Conference:

a. The committee be continued.

b. The "Guide for Interpreting Engineering Uses of Soils" is in short supply. The committee recommends that copies of the guide be made available to potential users very soon by (a) reprinting and widely distributing the present guide or (b) publishing and distributing a revised guide at an early date.

2. Report of the Southern Region

The Southern Region worked hard on two objectives:

Charge 1: Assemble and circulate instructions and rating criteria for the preparation of soil survey interpretation sheets. Series interpretation sheets were designed and the guides developed, assembled and distributed to committee members for review, testing and comment, Charge 2: Test procedures by preparing soil survey interpretation sheets for each series with responsibility in the Region. A procedure was initiated whereby series interpretations are developed, reviewed, and coordinated among surrounding states and adjoining regions, The procedure is essentially the same as that used to review series descriptions.

Committee Recommendations:

a. That the work-sheet be accepted for use in the southern region and considered by the Washington office as a national form.

b. That the guides for making soil survey interpretations be accepted for use in the Southern Region and be considered by the Washington office in developing national guides.

c. That the Washington office make a number of changes in guides appearing in Soils memorandums 45 and 69.

d. That the committee be continued.

e. That specialists in plant science and engineering be invited to membership in the committee,

3. Report of the West Region

The committee performed well on its two objectives:

Charge 1: Propose uniform criteria for engineering interpretations of soils. Twelve guide sheets were proposed, representing the combined thinking of many individuals, The guides are for septic tank filter fields, lagoons, sanitary landfill, local roads and streets, reservoir areas, shallow excavations, dwellings, pond embankments, probable source of sand and gravel, source of topsoil, roadfill, and available waterholding capacity,

Charge 2: Outline for guide book to engineering interpretations of soils. An outline was developed, mainly for users of the soil survey, having these main headings:

I. Foreword

II. Soil Terminology and Soil Identification

III. Soil Formation and Classification

IV. Glossary of Terms

V. Bibliography

The committee also recommended that moist consistence be determined at the moisture percentages of the plastic limit. This will make moist consistence values more meaningful to the engineers using the soil survey information.

The committee recommended it be continued and that one of its charges be to prepare a draft guidebook.

4. Report of the Northeast Committee

The committee members made excellent progress on their five charges,

Charge 1: Technical Handbook for Soil Survey Interpretations. The committee considered the format and content of a handbook and recommends the National Committee review it and make assignments for writing the various chapters.

Charge 2: Development and testing procedures for coordinating soil survey interpretation. The committee recommends a series of workshops to develop criteria and develop tables of interpretations by major land resource areas. These coordinated tables would be the basis for preparing single-sheet interpretations.

Charge 3: Information programs for specialists in other disciplines. The committee recamended that training and educational programs be centered around a permanent committee organized in each state, consisting of at least the State Soil Scientist, Experiment Station Representative and Extension Service Specialist.

Charge 4: Testing the broad general ratings for specific land uses. The committee recommends that the color code system (red, yellow, green) be retained, that both the degree of limitation and the soil properties responsible be stated, and that specific problem interpretations should continue to be made in conjunction with important soil properties affecting the indicated land use.

Charge 5: Engineering interpretations which have presented special problems. A number of comments and suggestions were offered to improve the interpretations.

D. Discussion of regional proposals.

1. The regional committees have fulfilled their charge of developing and testing criteria for preparation of soil survey interpretations. These reports reflect a great deal of effort as well as providing a diversity of thought from which to draw. They were considered in the revision of the "Guide for Interpreting Engineering Uses of Soils" now being edited, The regional committees are to be commended for their outstanding work.

2. The Northeast committee recommends a procedure for coordinating soil survey interpretations. The procedure involves a series of workshops to develop tables of interpretations by major land resource areas. The other regions are coordinating interpretations by correspondence, sending series interpretation sheets for review and comment to the states and regions that use the series. The National committee feels that the method of coordination is of secondary importance (although a majority of committee members preferred coordinating the single-sheet interpretations by correspondence). More important is that coordination be achieved. The committee feels that this can best be accomplished by agreeing on a set of criteria and applying them uniformly. The expanded "Guide for Interpreting Engineering Uses of Soils," soon to be released is a step in the right direction. Guides for the other disciplines need to be developed, The necessary steps in achieving uniformity are:

   a. Develop criteria,

   b. Get local, regional and national agreement that the criteria are meaningful and relate to the interpretations being made.

   c. Make the criteria available and understood by those who are making and using the interpretations.

3. The Northeast and West committees worked on format and content of a handbook for soil survey interpretations. The Northeast considered a handbook combining guides for making all kinds of interpretations -- woodland, wildlife, recreation and town and country, as well as engineering. The West considered a guidebook for users explaining soil science terms and procedures.

   The National committee favors a handbook for all interpretations mainly for the soil scientist, but not necessarily exclusively so. The advantages are to achieve coordination and the convenience, to all who make interpretations, of having all guidance materials in one reference. It may take awhile to develop all the chapters in the handbook, In the meantime, guidance on separate classes of interpretations, particularly engineering interpretations, should be issued as soon as they are ready.

4. The Northeast committee recommends that states organize to give training and educational programs to specialists in other disciplines.

   The Regional committee favors this approach, inasmuch as communications is one of the major obstacles to interdisciplinary cooperation. Individual training or educational programs should be developed for the professional engineer, forester, or regional, county, or city planners giving specific information and details on how he can use soil surveys. These programs should be developed cooperatively by the state soil scientist, experiment station representative and extension service specialists.

E. Recommendations to the regional committees:

1. The revised "Guides for Interpreting Engineering Uses of Soils" will be in looseleaf form and can be revised as conditions warrant. Regional committees are invited to review and test the guides and propose revisions. Although regional reports were considered in the revision, many compromises (hopefully the right ones) had to be made. Additional testing and revision are necessary for continued improvement.

   Any office sensing the need should submit revisions through normal channels for approval.

   A certain amount of leeway is built into the guides; enough, we hope, to accommodate the leeway most states need. After all, the interpretative ratings must be the same across state lines; and, hopefully, by prudent application of the criteria, the interpretive ratings will be uniform across the country. We must recognize that exceptions may need to be made for some soils in some states. If field observations clearly indicate that, by applying the criteria strictly, the interpretive rating is obviously wrong, the state, with approval from the principal correlator, will bc authorized to give the soil the rating judged most appropriate when compared to a large number of soils rated according to the criteria,

2. Regional committees are invited to develop and test new interpretations not previously covered. The usual channels for approval should be used.

3. Develop an outline of a Handbook for Soil Survey Interpretations. The outline developed by the Northeast Region is attached (Appendix 1) to stimulate thinking on possible content. The objective of this handbook is to supplement the discussion in the Soil Survey Manual, The chapter on Soil Survey Interpretation in the Manual will deal mainly with the principles and perspective of the subject. This handbook will deal with the specific guides.

4. Some of the estimates we make of certain engineering properties are in need of refinement. Regional committees are invited to deal with the following problems and others they may have:

   a. Permeability: This has reeeived a good deal of criticism in the reviews of the revised draft of the engineering guide. Some say we have too many classes. Others ask what do we really mean by the estimates and still others say that engineers don't (or can't) make use of the estimates we provide.

b. Corrosion: An in-depth study is needed on the relationship of corrosivity to kinds of soil. Our criteria for corrosivity of both steel and concrete are not as sound and applicable as they ought to be. The Soil Survey Laboratory in Lincoln has been accumulating data on resistivity of saturated soil paste as related to the conductivity of water extracts from saturated paste. These data may help us make better estimates of corrosivity.

c. Allowable soil pressure (load-supporting capacity): Engineers quite consistently have advised us against offering quantitative estimates of allowable soil pressure. Yet there is need and demand for such interpretations and our response today is poor. We need some way of interpreting allowable soil pressure and expressing it in such a way that planners and builders can make use of it even though we may stop short of giving quantitative values.

d. Subsidence: Subsidence of the soil surface can occur from several causes, but most of them in humid areas come about because of drainage, and, in arid areas, from wetting of dry subsoils or substrata. Rough estimates of potential subsidence in many situations can be predicted from soil survey. With further study and development of appropriate guides, we can improve our capability of making sound predictions of subsidence.

e. Landslides: There is need for interpretations about susceptibility of soils to sliding downslope. Insurance against mudslides or mudflows will be possible in connection with flood insurance, and the people who administer the National Flood Insurance Act will be looking for information that will be helpful in evaluating risks of mudslides. Claims have been made that something about susceptibility to mudslides can be interpreted from soil surveys, but we don't have any specific guidance about how to deal with this.

f. Dispersion: Dispersion has been a rather misunderstood soil property. A test has been developed which appears to give consistent results. Classes of dispersion need to be devised. Engineers are interested in working with us on this.

F. Recommendations to the National Committee

1. The National Committee should be continued.

2. Charges for the National Committee:

a. Receive and review proposals made by the regional committees.

b. Test and evaluate these proposals for the improvement of soil survey interpretations.

c. Evaluate the advantages and disadvantages of Regional versus National handbook for Soil Survey Interpretations,

G. Discussion from the floor of the Conference.

Dr. Gerald Olson -- New York State is printing all interpretations of each series together with the criteria sheets. These will be the actual interpretations -- not the guide on how to make them.

Bartelli, Orvedal and Klingebiel each made comments concerning the use of the revised guide for engineering interpretation. Klingebiel indicated the revised guide is now in the hands of the Information Division for editing.

Johnson questioned whether there will be overlap and duplication between the guide and the revised Soil Survey Manual.

Young responded that the guide is a "how to do" for soil scientists,

Cline stated that it is intended that the Manual should give the general approach to making interpretations and the principles involved. It would refer to the guide for details of how to do. However, Dr. Cline indicated there is a problem that all users of the Manual will not have copies of the guide.

Drs. Kellogg, Bartelli and Flach each discussed the complications involved in predicting the susceptibility of steel and concrete to corrosion. Dr. Kellogg pointed out that there are many factors influencing corrosion other than other than soils.

Grossman stated that acidity and resistivity (conductivity) are the principal soil features mostly influencing corrosion of steel in soils.

Flach said we can give data showing hazards to corrosion -- but we cannot indicate degree of limitation.

Young asked whether the matter of interpreting for corrosivity should be referred to the regional committees for further study. The conference consensus was "yes."

Dr. Kellogg pointed out that the committee report did not list frost action susceptibility as a key interpretation, He indicated that this interpretation should be kept in the foreground for many regions of the country. The end of allowed time precluded further discussion.

It was moved and seconded that the conference accept the Committee 5 report.

The motion carried.

Committee Members:

*Keith K. Young, Chairman, Port Worth, Texas
*R. C. Enderlin, Recording Secretary, Washington, D. C.
*L. E. Garland, Upper Darby, Pennsylvania
R. H. Jordon, Lincoln, Nebraska
L. N. Langan, Portland, Oregon
W. C. Lynn, Lincoln, Nebraska
J. T. Maletic, Denver, Colorado
*A. C. Orvedal, Washington, D. C.
*Adrian Pelzner, Washington, D. C.
Harold Rib, Washington, D. C.
R. D. Yeck, Beltsville, Maryland

*Present at conference

Appendix 1

- First Approximation -

HANDBOOK FOR SOIL SURVEY INTERPRETATIONS

Chapters to be Considered

Part I. Introduction

Chapter 1

Philosophy and Principles Involved In Soil Survey Interpretations

(This chapter could consist of the paper written by Dr. Charles E. Kellogg issued in April 1961 or could be similar material prepared by someone else. Land use patterns and soil related problems could be reviewed and exemplified.)

Chapter 2

Soil Survey Interpretations For Small Scale Haps

(The book "Soil Surveys and Land Use Planning" published by SSSA and ASA in 1966 contains information about use of soil surveys in county and regional planning. There is a great deal of information which is now available to develop this chapter.)

Part II. Farming Interpretations

Chapter 3

Soil Survey Interpretations For Cropland

(This chapter could contain an explanation of the capability classification system, such as that in Agriculture Handbook 210, and guide sheets with criteria for classifying the land into capability classes and subclasses. Also, a discussion of yield estimates for defined levels of **management** should be included. The committee felt there is still a need to settle on a system for converting our Capability Classes into a three-color interpretive system for intensive cropping for use by planners.)

Chapter 4

Soil Survey Interpretations For Pastures and Range

(Than is no national classification system for classifying soils according to suitability for pastures.)

Chapter 5

Soil Survey Interpretations for Woodland

(This chapter could draw from revised Soils Memoranda 19 and 26 and other criteria developed by regions for making soils-woodland interpretations.)

Chapter 6

Soil Survey Interpretations For Wildlife

(The Northeast Region for several years has used a system for making wildlife interpretations. This chapter would contain an explanation of the system and provide guide sheets of criteria for rating soils for development of wildlife habitat elements and rating them according to suitability for classes of wildlife. The wildlife interpretive system still needs some work.)

Part III. Nonfarming Interpretations

Chapter 7

Soil Survey Interpretations For Recreation

(This chapter would discuss some of the principles and assumptions involved and could draw from the guide sheets attached to Soils Memorandum 69.)

Chapter 8

Soil Survey Interpretations for Town and Country Planning

(This chapter would have a discussion and contain guide sheets for such uses as foundations for houses, streets and low cost roads, septic tank filter fields, sewage lagoons, sanitary landfills, excavations, trees for windbreaks, shade trees. plants for screening, ornamentals, etc.)

Chapter 9

Soil Survey Interpretations For Engineering Uses

(This would consist of a revision of our present guide. Mr. Orvedal, Assistant Director of Soil Survey Interpretations, is presently preparing a revision of the Guide for Interpreti Engineering Uses of Soils.)

Chapter 10

Soil Survey Interpretations For Tax Assessment

(Many areas are now basing tax assessment on soil surveys and several systems have been developed.)

Part IV. Coordination of Soil Survey Interpretations, their use in Legislation, and limitations.

Chapter 11

Coordination of Soil Survey Interpretations

(Interpretations for comparable phases of soil series require coordination across state and regional boundaries. Methods for getting this job done might deserve discussion in the handbook. As we are getting into automatic data processing, we might want some discussion of using the computer to aid us in coordination.)

Chapter 12

Legislative uses of soil survey interpretations

(A discussion of how surveys can and have been used in developing zoning, ordinances, legislation, etc., may deserve attention.)

Chapter 13

Interpret&e techniques for special objectives

(A number of special interpretive tables and example interpretive maps and overlays are available from various states. Perhaps this could be included in Chapters 1 or 8.)

Chapter 14

Interpretive and cartographic limitations

(It should be pointed out that soil interpretations can only go so far. Also cartographic limitations on color work, scales, costs, etc., should be considered.)

Report of Committee 6--Handling Soil Survey Data (for more complete and accurate syntheses of data on soils to improve classification and predictions by use of electronic equipment).

A. Introduction.

1. At the January 1967 Work-Planning Conference of the National Cooperative Soil Survey (NCSS), a suggestion was made that this Survey "should take a serious look at potential uses and practicality of ADP methods in its activities." his look was taken. The conclusion was that the NCSS indeed had much to gsi" from appropriate use of ADP. By January 1969, the concept of a soil data system (SDS) had bee" developed, a first draft of a system for coding pedon data had been written, and a new national committee made its first report.

B. Objectives of this committee are restated.

1. The broad, long-range objectives of this committee is to consider, evaluate, and recommend ways and means for achieving more complete and accurate analyses and synthesis of data o" soils for the improvement of soil classification and soil predictions by use of electronic equipment.

2. me immediate and limited objective is to report 0" developments to date, to evaluate the present status, and to recommend action o" a national system for coding data about soil pedons (profiles).

C. Developments and Present Status.

1. The soil data system (SDS), as originally conceived, is oriented more toward storage and retrieval than computation, although many computations, including multiple correlations, must be possible. This orientation remains unchanged; but the major parts, originally termed files, are now more appropriately considered as subsystems. Descriptions of these subsystems, slightly revised, are restated.

   a. Pedon data (PD) subsystem contains individual pedon (profile) descriptions and laboratory data (chemical, physical, and biological) for the described pedons. This subsystem may contain descriptions without laboratory data but not the reverse.

   b. Soil classification (SC) subsystem contains a record for each soil series which gives its placement, if known, in the soil taxonomy system. it also shows the status of each series and the state which has the type location. Computer programs in the subsystem will list all series in alphabetic sequence with the above information and also list sll sail families and their included series.

   c. Series description (SD) subsystem will contain all of the current series descriptions.

   d. Soil interpretations (SI) subsystem will contain the data on soil survey interpretations (predictions) including estimated yields, limitation ratings, etc.; and it also will contain data on soil use (or experience).

   e. Cartographic soil data (CSD) subsystem will contain data about the geographic distribution of soils so as to be retrievable in both tabular and graphic forms.

2. Status of the subsystems

   a. Pedon data (PD) subsystem: The national code proposed 2 years ago has just bee" revised to reflect, insofar as feasible, the suggestions Of reviewers, results of limited ADP experience with pedon data at a few state universities and two soil survey laboratories, and also to conform with certain regulations of the Federal Information Processing Standards (FIPS). As our committee concerned itself mainly with the pedon data subsystem, it is treated in some detail later in this report.

b. Soil classification (SC) subsystem: Because the use of computers for handling data for Volume 2 of the Soil Taxonomy Manual seemed particularly advantageous, work on the soil classification subsystem was given high priority. It has been developed to the operational stage and September 1970 marks a milestone. The", we had for the first time in the United states, a nearly complete list of soil series showing both their status and their placement in the soil taxonomy system. The second part of this printout shows all the soil series grouped into soil families. As copies of this material are being checked in the field, this draft is not final; but, preparation of the fins1 draft will be rather easy and inexpensive; it will demonstrate how rev'sions--new editions--can be made as needed in the future.

c. Series description (SD) subsystem: No developmental work has been done yet, but much of the material prepared for the pedon data subsystem will bc applicable to the SD subsystem.

d. Soil interpretations (SI) subsystem: Development of a part of this subsystem is well along. This part has to do with recording interpretations already made, such as expected yields of crops, land capability classification, and limitation ratings for selected uses. Work is underway at two places.

One is at the SCS Regional Technical Service Center at Ft. Worth where the subsystem is being developed mainly for the purpose of streamlining the preparation of soil survey manuscripts by using the computer to assemble and print interpretive tablet.

The second place is the Statistical Laboratory at Iowa State University, Ames, Iowa, where an effort is underway to expand the information deducible from the original data collected for the Conservation Needs Inventory (CNI). This involves the augmentation of the original date, I" two steps. First, the SCS state offices are adding soil names--series names wherever possible--to the soil symbols shown 0" the area CNI samples. (The original CNI raw data do not show the series names although they do show surface texture, slope, and erosion class). The second step of the augmentation comes from the addition of interpretive data --estimated yields, limitation ratings, etc. By combining these augmented data with the acreage estimates already made for the CNI data, many statistical studies involving the areal extent of selected soil interpretations will become possible. Such studies will become possible for any interpretive information that has been related to named kinds of soils for a variety of areas such as states, land resource areas, regions, and the entire nation.

Essential to the operation at both Ft. Worth and Ames is a data bank of interpretations show" on the single interpretive sheets for soil series. Data formats at the two places will be identical so that duplicate card punching CA" be avoided.

e. Cartographic soil data (CSD) subsystem: Developmental work on this subsystem is related to, and controlled by, development of the SCS Advanced Mapping system (AMS). Excellent progress is being made; but most equipment is yet to be acquired and considerable programming remains to be done. Early 1972 is the target date for having the advanced mapping system operational; and, once this becomes operational, we will begin to get geographic soil data for the data bank. A "copy" of every soil map processed by this AMS system will be placed in the data bank.

D. Regional committee reports: Three regional conferences had committees dealing specifically with handling soil survey data. The fourth (North Central) discussed ADP in its committee on Coordination and Dissemination of Laboratory Information. Highlights of the regional reports follow:

1. All committees urged that the NCSS move ahead on developing standard ways of handling soil survey data. This pertains particularly to the pedon data subsystem.

a. The Western Committee acknowledged that the pedon data coding system appears to be largely satisfactory and specifically recommended that it be finalized as soon as possible without major modifications.

b. The North Central Committee did not make any specific recommendations about the pedon data coding system, but did note that efforts should be directed toward the improvement of it, especially in the areas of describing the landscape, and the stratigraphy of parent materials. The North Central Committee did recommend that states developing ADP programs for handling soil information should coordinate their programs with the Federal system as much as possible. Incidentally, the North Central Committee recommended for its own objectives the development of systems for describing landscape units and parent material stratigraphic units suitable for ADP.

2. Two regional committees (Western and Northeast) reported on a survey of the use of ADP in handling soil survey data. Most of the uses involved selected soil data in combination with data on vegetation or other phenomena which were being related to soils. A third committee (Southern) noted that several local and regional planning units are using ADP to handle data, including soil interpretive data.

a. In the Western Region, at least five universities (2 in California), the Forest Service, and one state department of natural resources are making substantial "se of ADP; and, in the Northeast, at least 4 universities and the Forest Service are doing the same.

3. The regional committees reflected an urgency for developing codes and formats that need to be standardized nationwide. This urgency applies particularly to the pedon data subsystem.

4. The Western Committee recommended the establishment of a national clearinghouse to maintain tapes Of Soil Survey data, relevant computer programs, and to service the NCSS with information on the use of ADP.

5. The North Central Forest Soils Committee also had an item about ADP. This committee recommended, in regard to forest site quality studies, that closer working relations be established between data collection agencies, research agencies, and statisticians familiar with advanced computer techniques.

E. Other developments related to ADP in the Soil Survey.

1. It is now commonplace to have Soil Survey laboratory computations done by electronic computers. (The same probably is true of many land grant universities). At tile Soil Survey laboratory in Riverside, a data bank of laboratory data, on disks, has been started. Also, a program has been written to make computer printouts of laboratory data such that, after photographic reduction, they are ready for direct inclusion in Soil survey Investigation Reports.

2. Development of a woodland data system (WDS) is well along and detailed instructions have been issued for coding the woodland site index records. This system is compatible with the soil date system, so that data from one can be drawn for use in the other. The woodland site index records include the soil name and certain soil features, but they do not include detailed pedon (profile) descriptions that were made at many of the sites. The descriptions of acceptable quality will be put in the soil data system.

3. Development of a range data system (RDS) also is far along, and it is compatible with the soil data system too. The plant yield records will indicate the name of the soil and hence will be usable with records in the soil data system.

4. States are being asked (Soils Memorandum in draft) to set up end maintain a register of soil site numbers. The objective is to have a unique number, within a county, for every site from which soil or soil-related data are collected that end up in ADP data banks. Once a number is assigned, it will be used whenever additional data are gathered from the same site. This number, along with the established code for county and state, will be entered in all ADP records and will be helpful in recalling data for any given site.

5. The South RTSC at Ft. Worth, in addition to its developmental work with soil survey interpretations (C2d), is developing ways to exploit ADP for several other soil survey procedures, including soil correlations.

6. The Northeast RTSC at Upper Darby is developing, for the SCS Connecticut state office, procedures for printing out selected interpretive information, along with acreages, for kinds of soils shown on soil maps of areas such as towns and planning districts.

F. Discussion.

1. The revised coding system for pedon data is basically like the system described in the report of this committee two years ago, but, in addition to numerous minor changes, some major ones were made:

   a. The complete set of data for a pedon, instead of making up one long record, has been divided into three. The first will contain information provided in pedon descriptions. The second will contain laboratory data like those issued by Coil Survey laboratories. The third will contain laboratory data like those issued by the highway engineering laboratories. (The coding system at this stage does not yet have instructions end codes for the engineering laboratory data; these will need to bc added later).

   b. It is assumed that many, perhaps most, offices or laboratories preparing pedon data records will want some data in addition to those specifically provided for in the national code. These data may be about items such as yields of crops, more details about vegetation or physiography, or the names of geologic formations. Accordingly, the revised format provides reasonable amounts of space for such additional data. I" sharing the tapes with others, two options are possible. The more common one will be for the second office to program the computer to ignore the "local" data added by the originating office. The other option is for the second office to obtain the relevant codes from the originating office so that the data can be used.

   c. A third major change is the provision for Indicating the upper and lower limits of the control section, and also to indicate whether the traditionally recognized horizons (Al, B2t, etc.) also belong to diagnostic horizons or contain diagnostic features, such as durinodes, that nay not be routinely included In descriptions. As this information normally is not included in soil descriptions, it will need to be added by the soil scientist who does the coding. Such information will make pedon data records more useful in soil classification; but, perhaps more important, it will make much easier the retrieval of data on control sections, diagnostic horizons, or other diagnostic features.

   d. The document setting forth the details of the coding system, being long--about 100 pages-- is not a part of this committee report; but Appendix I attached to this report describes the document and explains important features of the coding system.

2. Interest is great in the "se of ADP for soil survey interpretive data; and, as mentioned in C2d, developmental work is underway. Nearly all of this work, however, deals with handling interpretations already made, or about to be made according to firm criteria. Another aspect of soil survey interpretations needs attention too. This has to do with making full use of available data for updating or verifying interpretations. Among such data may be results of yield studies, fertilizer trials, tillage studies, and records of observations of the performance of soils used for septic tank absorption fields, foundations for houses, and many other uses. Research is needed to find practical ways to update repeatedly the soil survey interpretive data in the data banks.

3. A national clearinghouse, or some kind of a system or facility, is needed to maintain records and provide services and information on ADP for the National Cooperative Soil Survey. Questions about what data are in data banks, "here the data arc stored, what programs have been written, etc., are important questions to which up-to-date answers will be needed repeatedly. Also, procedures for updating national codes will be needed--for two reasons. One is that ways for improving the codes will unfold as experience is gained. The second is that the new edition of the Soil Survey Manual will make some changes necessary.

G. Recommendations.

1. That the coding system for pedon data, as revised, be released with the understanding that its use for the first year or two will serve to test the code. A need for some revision is anticipated after testing by actual use and after issuance of the new edition of the Soil Survey Manual. (Note that this system still lacks the instructions and codes for data from highway engineering laboratories).

2. That instructions and codes for data issued by highway engineering laboratories be prepared and tested so as to complete the pedon data coding system.

3. That a procedure, perhaps involving a clearinghouse of some sort, be established for servicing NCSS with ADP information relevant to the soil data system and other systems compatible with it. The procedure needs to be such as to make easy and convenient the exchange or sharing of data in the soil data bank(s); to know what relevant computer programs have been written, tested, and are available; to update national codes; and to promote liaison among people using ADP for handling soil survey data.

4. That state experiment stations be encouraged to develop programs for making full use of experience data (yield studies, fertilizer trials, observation of engineering behavior, etc.) for updating or verifying soil survey interpretations.

5. That this committee be continued. Proposed activities are:

   a. To monitor and evaluate continuing efforts to improve handling and use of Soil survey data.

   b. To call the attention of the National Cooperative Soil Survey leadership to new techniques, procedures, or equipment far data handling that merit evaluation and testing for possible use in soil surveys.

6. That regional committees survey the use of ADP at state and regional levels, evaluate the coding system for pedon data, evaluate other parts of the soil data system as they are developed, and suggest additional practical uses of ADP in the handling of Soil Survey data.

Committee Members:

R. J. Arkley	R. B. Grossman	*G. W. Peterson
*J. B. Fehrenbacher	*John 4. Hawley	R. H. Rust
K. W. Flach	P. E. Lemmon	D. W. Swanson
*D. P. Franzmeier	Olaf C. Olson	L. P. Wilding
		A. C. Orvedal, Chairman

*Not present at the Charleston Conference.

Conference Action

This report was accepted without change.

Appendix I

Coding System for Pedon Data

1. The document (about 100 pages) describing the coding system for pedon data (PD) is made up of the following:

   Part A - General. A brief discussion of the concept, purpose, and structure Of the PD records.

   Part B - Item list. A listing of the items and subitems in the PD records along with some information pertinent to coding.

   Part C - Instructions and codes. A listing and discussion of the codes and entries for each item and subitem in the PD records. This part is subdivided into 2 sections --the first for field descriptions (FD) and the second for data like Soil Survey laboratory (SL) data. (A third section for highway engineering laboratory data is to be added later).

   Part D - Appendix. Mainly illustrations of the PD records, a discussion of probable record length;, and illustrations of sets of coding sheets for data cards for inputting the data.

2. The broad spectrum of information encompassed by the term "pedon data" has been divided into three records. The first, field description (FD), is to contain information provided in pedon (profile) descriptions. The remaining two records "Ill contain laboratory data. Results like those obtained in Soil Survey laboratories will be accommodated in the second record, Soil Survey laboratory (St) data; and results like those obtained from highway engineering laboratories (HI,) data, will be in the third. The coding system has been developed for the first two records, but not yet for the third.

3. The FD and SL records are rather long, but long records seem unavoidable if the complete range in descriptive material and laboratory data for soils of the entire United States is to be accommodated. For no single pedon are there likely to be entries in all data fields, and a device for shortening the records in many places is provided.

4. It is assumed that nearly every office inputting data will want some data entered in addition to those called for by the national code. A modest amount of space is provided for such "local-interest" data, entered according to local codes rather than the national code and for local use rather than interstate or national use.

5. Partly because the FD records are long, the code is designed with the assumption that this record will be put an tape. To use cards is possible, but because of the record lengths, so many cards will be needed that their use for PD records will be cumbersome.

6. The records are designed to facilitate computer programming for searching for and retrieval of any desired items of information or any combination of such items.

7. Insofar as possible, the records are designed to accommodate information exactly as it is given in sail descriptions and laboratory reports, but some interpretation of original information, particularly of soil descriptions, will be necessary to fit the information into classes provided in the record. While clerks can be trained to enter most of the data, the services of soil scientists will be needed for some of the coding.

8. To encode descriptions and laboratory data directly as specified for the PD records is possible but is not recommended. For parts of the PD records, the procedure can be simplified by encoding original information more nearly as it is in descriptions and using the computer to make the conversions to the codes specified for the P" records. For example, instead of having the encoder enter "5" for yellow, he could enter the Munsell notation "Y" and the computer can be used t" convert the "Y" to "5". Errors can be reduced and considerable edit-checking accomplished by this procedure. The procedures developed and followed for getting data into the PD records are expected to vary somewhat from office to office depending upon help and facilities available locally, and complete standardization of such procedures is not proposed. What is proposed is that the P" records--the records for storage, retrieval, and interchange--conform to a rigid format regardless of how this conformity is attained.

9. The proposed PD record does not yet provide for grain-size data and certain other data that we get from soil engineering laboratories. No particular difficulty is envisaged in making provision for these data if the basic features of the proposed format are sound.

REPORT OF THE COMMITTEE ON HISTOSOLS

This is the first report prepared by this committee since the committee was reactivated. The last National Technical Work-Planning Conference was prepared for the January 1965 conference in Chicago.

The preparation of this report followed the same procedure that was used by other committees at the preceding National Technical Work-Planning Conference. The chairman, in the form of a memorandum to all committee members, briefly outlined the status of the classification of organic soils, work that has been done to date. and existing problems. Regional reports, suggestions submitted for consideration, and proposed tests for organic sail materials were also furnished the committee members for their review and comment along with a request for additional items that should be considered by the committee. Except for working in the field with the committee members who received testing kits for trial use. the report was based on correspondence.

This is the first report since reactivation of the committee. Based on the present status of our knowledge of organic soils, the committee suggests that the charge be as follows:

> To stimulate activity in this field of soil science and to receive and evaluate proposals and recommendations submitted by regional committees for the improvement "f mapping, classification and interpretations of organic soils,

Regional Reports

The North Central Region was the only region that submitted a report. IL recommended:

1. that the National Committee 0" organic Soils be reactivated;
2. that as soon as possible all states prepare soil series descriptions of the Histosols that are presently being mapped;
3. that each state determine at least the pH, fiber content, mineral content and bulk density of their principal organic sails;
4. that states encourage research on hydrology and genesis of their organic soils and on the relationship of older research to the present soils classification system;
5. that states collect soil temperature data in organic soils;
6. that the terms "muck," "peat," and "peaty muck" not be used in describing the layers of the typifying pedon or in other sections of the standard series description but these terms may be used to designate phases such as "Carbondale muck";
7. that tiers rather than depths be used in the range of characteristics in discussing the three principal subdivisions of the control section for example, "The middle tier is dominantly hemic material";
8. that the National Committee obtain taxonomic keys of organic soils from each region and prepar a consolidated key.

Comments and Suggestions from Committee Members

1. Terminology:

Mr. Austin proposed that the following terms should he used as substantives for the kinds of material described in organic soils:

Fibric material	Fibran
Hemic material	Heman
Saptic material	Sapran
Limnic material	Limnan
Coprogenic material	Coprogenan
Diatomaceous material	Diatoman
Ferrihumic material	Ferrihuman
Humilluvic material	Humilluvan
Marl	Marl

2. Subsidence:

Dr. DeMent pointed out the need for a means of predicting subsidence potential for Histosols and submitted a copy of "Criteria for Rating Soils for Subsidence Potential" that was prepared in Louisiana. (Copy attached.)

3. Research:

Dr. Gerhard Lee, Wisconsin, furnished each committee member a reprint from the Soil Science Society of America Proceedings on "Chemical Differentiation of Selected Wisconsin Histosols" in which he was a coauthor. This article discusses a part of his work on chemical differentiation of organic materials in the laboratory and relates the use of sodium pyrophosphate as an extractant.

4. Classification:

Dr. Warren Lynn, Lincoln Soil Survey Laboratory, had the following comments:

"1. Coarse fragments. Presently, wood fragments greater than 2 cm in cross section that do not break down upon rubbing arc considered coarse fragments. A break at 4.75 mm (No. 4 sieve) or 2 mm would allow a more reasonable subsampling for fiber analysis. The 2 cm break requires such a large sample that it is difficult to rub out. One other aspect, the breakdown of woody peat to pass the 100-mesh sieve has not been tested sufficiently. Perhaps woody peat and non-woody peat need to be treated differently for estimating fiber.

"2. Live roots. It is virtually impossible to make fiber estimates, other than visual, that are exclusive of live roots. Besides the problem of separating an intricate mixture of live roots and other material, it is often difficult to determine if the root is alive.

If live roots are to be separated, presumably they would be distinguished by morphology. Written criteria are needed. Directions are needed for handling layers that are essentially all live roots.

A more reasonable approach seems to be to not exclude live roots smaller than coarse fragments from Histosol material.

"3. Fiber (volume) content. The fiber content is now determined as a percentage of the organic volume. Physically, Histosols have a fragmental organic skeleton with interstices incompletely filled with mineral material (considering only the solid phase). Mineral content must be around 80 percent, i.e., a mineral soil, before the interstices can be filled, even theoretically. In other words the bulk volume of the organic portion and the bulk volume of the natural material are synonymous.

From an operational standpoint it is impractical if not impossible to make fiber estimates except visually that exclude mineral material. Problems parallel those of excluding live roots. For these reasons fiber content should be given on the base of the total volume of material."

5. Aids to Mapping:

Sam Rieger, Alaska. discussed the need for a visual aid to help field soil scientists make an accurate estimate of the fiber percentages. He suggested that a card illustrating the appearance of fibers at various percentages, perhaps at critical points of 10, 33, 40 and 60 percent, should be prepared.

6. Tests of Organic Materials:

Laboratory procedures have been outlined by the Department of Soil Science, University of Minnesota for determining fiber content, bulk density, mineral content, and water content at saturation. These procedures are outlined in "Some Laboratory Methods for Analyzing Organic Soils," by R. S. Farnham, J. L. Brown and H. R. Finney, dated February 1970 (Copy attached.)

In the classification of Histosols the use of "Soil Taxonomy" requires the use of field tests to determine the color of pyrophosphate extracts, fiber percentages, and ph's in 0.01 M $CaCl_2$. Based on this need, a considerable amount of time and thought has been given to improving these tests for use in the field. Six kits were assembled. One kit was furnished to each region, one for the Soil Survey Laboratory, and one for the Technical Service Center in Lincoln. Based on the results of a few tests the procedure has been modified. A copy of the revised procedure is attached. In addition to the fiber tests, procedures for pyrophosphate color test and for ph are also included. The pyrophosphate color test, rubbed fiber test, and test for ph appear to give satisfactory measurements. There is a question regarding the use and significance of the calgon dispersion (unrubbed fiber test) and how it relates to the field estimate of the unrubbed fiber percentage. Because of the lack of experience in running these tests and the small amount of data available, the committee recommends that these tests continue to be made and at a future time reevaluate their importance.

7. Samples:

Dr. Warren Lynn suggested that about 40 "benchmark" samples were needed primarily for routine fiber tests and for reference samples for field personnel.

<u>The Committee Recommends that:</u>

1. the proposed fiber tests for organic soils should be tested in the field and the results should be evaluated; the tests will be revised as necessary after additional laboratory investigations and field experience;

2. the terms proposed as substantives for the kinds of material described in organic soils should not be adopted; (The committee recommendations on this proposal were divided but the majority opposed the proposal.);

3. the national committee members, with the assistance of the principal soil correlators, should instigate procedures to obtain the 40 "benchmark" organic soil samples requested by the Lincoln Soil Survey Laboratory;

4. the national committee members should investigate the possibility of preparing a visual aid to help the field soil scientists estimate fiber percentages.

<u>The Committee Recommends the Following Activites for Regional Committees:</u>

1. encourage states to determine the ph, fiber content, mineral content, and bulk density of the principal organic soils;

2. encourage states to do research on the hydrology and the genesis of their organic soils and to relate older research to the present classification system;

3. encourage states to collect soil temperature data of organic soils;

4. develop taxonomic keys for soils of the region;

5. develop meaningful consistence terminology for use in describing organic soils;

6. develop standard moisture (water content) terminology for use in describing organic soils;

7. review the table "Criteria for Rating Soils for Subsidence Potential" proposed by Louisiana and in regions that have pergelic soils revise or enlarge table to include subsidence potential classes for pergelic soils;

8. evaluate test data and recommend if the rubbed fiber percentage for sapric materials should remain at 10 percent or be raised to 15 or 20 percent.

It is Recommended that this Committee be Continued to:

1. review and evaluate proposals and recommendations for the improvement of classification. mapping and interpretations of organic soils received from the regional committee;

2. furnish guidance, as needed, to states using the organic field tests. Based on additional experience and data, improve and revise procedures as needed.

Committee Members:

Morris Austin
J. E. Brown*
R. L. Cunningham
John Day
J. A. DeMent
R. S. Farnham
H. R. Finney
R. W. Johnson
L. W. Kick
Gerhard Lee
W. C. Lynn
William McKinzie, Chairman*
E. J. Pedersen
Samuel Rieger
David Slusher

*Present at conference

Notes on Discussion of the Report by the Conference:

Bartelli: Suggested that the charge of the committee on Histosols should be broadened to include the Hydraquents. Kellogg pointed out the committee name would have to be changed.

Rourke: Agreed with Bartelli that the Hydraquents should be included with Histosols and that further study is also needed on the Hydraquents. The conference voted to approve the recommendation. (Thus the committee will now be renamed "Committee on Histosols and Hydraquents".)

Pettry: Asked how a soil would be classified if coarse fragments comprised more than 80 percent of the volume -- mineral or organic?

Smith: Pointed out that fragments of wood that are larger than 2 cm in cross section and that are so undecomposed that they cannot he crushed and shredded with the fingers are not considered fibers.

Bartelli: Questioned Marlin Cline about the amount of material on field tests that should he included in the Manual. Cline said items that are being measured should be included.

The report was accepted by the conference.

Attachments -3

Criteria for Rating Soils for Subsidence Potential.
Some Laboratory Methods of Analyzing Organic Sails.
Field Tests for Organic Soil Materials.

CKITERIA FOR RATING SOILS FOR SUBSIDENCE POTENTIAL

Subsidence potential refers to the maximum possible loss of surface elevation from organic soils or soils with semifluid mineral layers. Estimates are made as to changes that take place as a result of drainage and oxidation, or oxidation alone if the soil has already been drained. This does not take into account geological subsidence. Subsidence of organic soils after drainage is attributed mainly to four factors: (1) loss of groundwater buoyancy, (2) consolidation, (3) compaction, and (4) biochemical activity. Elevation loss due to the first three factors is termed initial subsidence and is normally accomplished in about three years after lowering the water table. Initial subsidence of organic soils will typically result in a reduction of thickness of the organic materials above the water table by about one-half. After initial subsidence, shrinkage will continue at fairly uniform rate due to biochemical oxidation of the organic materials. This is termed continued subsidence and will progress until mineral material or the water table is reached. The rate of continued subsidence depends upon the depth to water table and increases with depth to water table.

Soils with semifluid mineral layers will have initial subsidence due to loss of water and consolidation after drainage and will have little if any subsidence thereafter.

Subsidence of organic soils can be stopped by maintaining the water level at the surface. It can be slowed by maintaining the water level as high as possible for the land use. Four subsidence potential classes are to be used in making soil interpretations.

Subsidence Potential as a Result of Drainage

Class	Subsidence Potential (inches)	Soils
Low	o t o 3	(1) Mineral soils with organic surface accumulations 0 to 3 inches thick. (2) Mineral soils with semifluid layers (greater than 100 percent saturated with water).
Medium	3 to 16	Mineral soils with organic surface accumulations 3 to 16 inches thick.
High	16 to 51	Organic soils with organic accumulations 16 to 51 inches thick.
Very High	> 51	Organic soils with organic accumulations greater than 51 inches thick.

La.-9/1/70

UNIVERSITY OF MINNESOTA
DEPARTMENT OF SOIL SCIENCE
ST, PAUL, MINNESOTA

February 1970

SOME LABORATORY METHODS FOR ANALYZING ORGANIC SOILS

by

R. S. Farnham, J. L. Brown, and H. R. Finney[1/]

The laboratory methods described below represent some techniques that have been used for several years in the Department of Soil Science, University of Minnesota, as well as others that have been used only recently. Most of the methods appear reasonably satisfactory to us, but further improvement is needed on the measurement of fiber content. Also, methods need to be developed to measure fiber content in the undisturbed condition and after rubbing and fiber density. Any suggestions for improving or modifying any of these m&hods will be welcomed.

1. Fiber Content

Presently, fibers are considered to be the particles of plant tissue that are retained on a 100 mesh sieve (0.15 mm openings). However, 60 and 160 mesh sieves have been used. A 10 to 30 g sample of organic soil or limnic material, as received from the field (moist weight), is weighed and added to one of the following solutions:

a. 200 ml of 0.025 M sodium pyrophosphste
b. 200 ml of 0.025 M sodium hexsmetsphosphate
c. 20C ml of 0.5 N hydrochloric acid

If the material is sapric, a larger sample (about 30 g) is used, Use a 1C g sample of fihric material. Concurrently, a 50 to 100 g sample (preferably two or three) from the same material is obtained to determine moisture content. (These samples can be used subsequently in the determination of mineral content and calcium carbonate equivalent.) The results of this analysis are used as a basis for determining the content of fiber since the nonfiber material is destroyed. Solutions of either sodium pyrophosphste or sodium hexsmetsphosphate yield the most reliable results. Presently we Prefer sodium pyrophosphste. Further, appreciably lower values of fiber content are obtained hy use of hydrochloric acid. The sample and solution are mixed slightly with a stirring rod end mixed for 5 to 10 minutes in a “milkshake” mixer. The slurry is left undisturbed for 12 hours, restirred briefly with a stirring rod, end slowly poured onto the sieve. If tha sample contains a mineral fraction larger than

1/ The first two are with the Dept. of Soil Science and the latter is with Soil Conservation Service.

157 /4/1

the openings oi the sieve, the fibers should be decanted from tho remainder of the slurry. Material remaining on the sieve is washed with a stream of water until the water passing through the sieve appears clean. If the material on the sieve contains fragments of shells, an additional washing with a 10 percent HCl solution can be used. followed by a brief washing with water. The material retained on the sieve is removed with water, placed into a weighing can, end dried to constant weight at 100 to 110 C. (about 12 hours are required). Thr fiber content on oven-dry weight basis is computed as follows:

Xn = sample for fiber analysis
Xm = sample for moisture determination
Xf = fiber

$$\%Xf = \frac{\text{ovendry wt. Xf}}{\text{moist wt. Xo (ovendry wt. Xm/moist wt. Xm)}} \times 100$$

In the field the content of fiber is estimated both in the undisturbed condition and after rubbing. In the former, vertical cross sections of the soil mass are observed with a 10X-hand lens and the fiber content estimated on the basis of volume of total soil, Pieces of the soil arc then rubbed about ten times between the thumb and forefinger. The soil is formed into a sphere, broken in half, and the broken faces observed using the hand lens. The fiber is estimated again on the basis of volume of the total soil. Therefore, an attempt should be made to convert the fiber content on the ovendry weight basis to a volume basis.

For materials with a low mineral content (< 10%), the percent fibers on the oven-dry weight basis approximates the volume of fibers.

An example for converting the content of fiber on the ovendry weight basis to volume basis follows:

a. Measured values:

D_b = 0.4 g/cm^3
Organic matter = 40 percent
Fiber = 10 percent
Total ash = 60 percent
Soluble ash = 10 percent
Sample is free of carbonates
All values are bared on total ovendry weight, except for soluble ash[1/] which is computed as follows:

$$\frac{\text{wt. soluble ash}}{\text{wt. organic matter + soluble ash}} (100)$$

b. Computations:

Soluble ash is considered a component of the organic fraction. Since subsequent computations are based on D_b for individual components, adjustments in the amount of mineral material and organic material plus soluble ash are made as follows:

2/ Refer to the section on "Mineral Content" for the reason for doing this.

(1) Convert percent soluble ash on basis of weight of organic matter to basis of entire snnple. If the sample weighed 10.00 g, organic matter weighed 4.00 g, ash weight 6.00 g, and the soluble ash weighed C.44 g, the 0.44 g would be added to the weight of the organic matter and the percentage would be recomputed. In this case, the percent of organic matter plus soluble ash would be 44.4 and mineral matter minus soluble ash would be 55.6.

(2) A value is needed for the bulk density of the mineral fraction minus soluble ash. We used 1.5 g/cm^3 for samples that are carbonate free. For samples high in content of free carbonates (75 percent calcium carbonate equivalent or more), a figure of 0.7 to 1.0 g/cm^3 might be more realistic. The computation is as follows:

% volume of mineral material minus soluble ash =

$$\frac{(0.556)\ (0.4\ g/cm^3)}{(1.5\ g/cm^3)}\ (100) = 15\%$$

Ry subtraction the percent volume of organic matter plus soluble ash = 100% - 15% = 85%. Assuming that the fiber and nonfiber material have the same bulk density, then:

% fiber on volume basis =

$$\frac{(.85)\ \ (.10)}{(.444)}\ (100) = 19\%$$

Refer to Figure 1 for correction factor for converting fiber on the oven-dry weight basis to the volume basis, Values were. derived in the manner shown above.

A simpler method of approximating the content of fiber on the volume basis would involve only the bulk density of the fibers. Perhaps these values would be on the order of 0.05 - 0.1 g/cm^3 for moss fibers and 0.1 - 0.2 g/cm^3 for other fibers. Presently we are in the process of experimenting with methods of measuring the bulk density of various kinds of fiber. If these values were used, the only other values needed would he the bulk density of the sample and the content of fibers on the basis of ovendry weight. The computation would be as follows:

a. Measured values:

D_b entire sample = 0.4 g/cm^3
Fiber content (percent ovendry weight) = 40
Assumed D_b value for herbaceous fibers = 0.2 g/cm^3

b. The computations:

$$(0.4)\ (0.4\ g/cm^3) = 0.16\ g/cm^3 \text{ fiber in sample}$$

$$\frac{0.16\ g/cm^3}{0.20\ g/cm^3} \times 100 = 80\% \text{ fiber by volume}$$

In the analysis for determination of the content of fiber, some points need special emphasis. Complete mixing of sample is essential. For example, samples mixed by hand with a stirring rod give somewhat higher and more variable results. Perhaps some fibers disintegrate in mechanical miring, but the amount does not seem significant. Also, the samples that are used for determination of fiber content and moisture content must be homogeneous, and both sets of samples should be weighed as near the same time after removal from the original sample as is possible, Some analysis of fiber content by boiling in 0.5 N HCl indicate that considerable fiber is destroyed.

In summary, we believe that by using either sodium pyrophosphate or sodium hexametaphosphate as dispersing agents, the values obtained fall somewhere between the actual content of fiber in the undisturbed condition and the content of fiber after rubbing and probably closer to the latter condition.

2. Bulk Density

The determination of bulk density in the field by direct sampling has been attempted by several methods. A description of three methods that appear to give more reliable results follows:

a. Extraction of a core using a double-walled cylinder

This consists of the following: an outside stainless steel cylinder with knife edge; inner components of one sample cylinder are two end retaining rings, an upper end fitted with a removable cover, and retaining pin; a standard hollow T-shaped handle; a 2 kg ram which fits the handle and drives the sampler into the peat. The ram is used to minimize distortion and compaction which often occurs when inserting a sampler by hand. The retaining rings were Lnstalled so that the sample endswhich are often slightly compressed and/or distorted can be cleanly removed, leaving the relatively "undisturbed" sample in the larger center cylinder. The volume of the core Ls 327 cm^3.

b. Steel mitre-box

This consists of a box with four adjustable sides in which a sample of organic soil material can be placed and cut as an equidimensional cube. A rough-cut cube is taken from the soil using a doubly-serrated knife, trimmed and placed Lo the mitrc-box for final cutting. Samples can either be cut in the field or wrapped and transported to the laboratory for final sizing. This method may be used to advantage with fibric materials easily compressed by conventional coring devices.

c. McCauley peat auger

On the basis of values obtained by the previous two methods, reliable measures of bulk density can be obtained by using the McCauley peat auger. The auger removes a one-half cylinder of material that is relatively undisturbed. A segment of the material is cut with a sharp knife, removed from the auger, placed in a sample bag, and the length of the segment recorded (the volume can be computed later). In the laboratory, both the sample weight as received and the ovendry weight are recorded. When the former values are compared with volume, estimates can be made with regard to degree of decomposition, especially if the samples were at or near saturation. The latter value is used to compute bulk density.

An excavation is required to obtain samples by the first two methods described, but, with the auger, samples readily can be obtained at any depth and even under saturated conditions.

3. pH

Presently, pH is determined by mixing the organic soil material in a 0.01 M $CaCl_2$ solution. Studies indicate that the ratio of sample to solution does not appreciably affect pH if it is in the range of one part organic soil material to one to five parts solution, both on a volume basis. Use a small paper cup (about 50 ml) and lightly pack enough sample into the cup to fill one-third the volume. Next, sufficient solution in added to bring the volume of sample and solution to two-thirds of the volume of the cup. It is mixed and allowed to stand for one-half hour and pH determined with a pH meter.

In order to obtain more data on the pH of organic soil materials, we generally determine pH using water and other salt solutions such as 1 N KCl, 1 N $BaCl_2$, or 1 N $CaCl_2$. Mixing ratios are the same as discussed.

4. Mineral Content

The mineral component in organic soil material may be separated into three fractions as follows:

a. Soluble mineral material (ash) which was an integral part of the original plant material.

b. Extraneous mineral material (ash) composed of noncarbonate minerals.

c. Extraneous mineral material (ash) composed of carbonate minerals.

The total mineral content, as well as any fraction of it, can be expressed as a percent of the total ovendry weight of the sample. However, since the soluble fraction is actually inherent in the organic material, it might more accurately be expressed as a percent of it (wt. soluble ash/wt. organic matter + wt. soluble ash).

In determination of total mineral (ash) content, an ovendried sample of peat is ground, placed in a crucible, and heated to 400 C. for 16 hours in a muffle furnace. This procedure does not require preignition.

The separation of soluble fraction is made by a treatment of the mineral component with 2 N HCl for 6 hours at room temperature and filtering through a 0.45 micron filter. If the material contained no free carbonates, residues remaining on the filter are considered to be extraneous mineral material. Soluble mineral material posses through the filter in solution.

If the material contains free carbonates, there are severe.1 methods which can be used for measuring calcium carbonate equivalent. They involve measurement of weight loss, measurement of evolved gas, and titration--all using a primary treatment with HCl. Presently we are using the volumetric gas technique (6Ela) as described in "Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples," USDA, SCS, Investigations Report No. 1, 1967. The results of this and other procedures vary with the condition of the peat, that is whether the sample is in the moist condition as received from the field, ovendry, or ovendry ash. This analysis seems most reliable when conducted on a sample in the former condition because some materials that behave as carbonate minerals appear to be generated in the ashing process. For example, some organic soil materials in the field condition show no reaction with HCl. Also, they have essentially no carbonates when the procedure mentioned above is used on a moist sample. However, when the same procedure is used on their ash, some carbonates are detected.

In material that contains free carbonates (before ashing) the procedure for measuring soluble ash is not used. Data on materials that are carbonate free indicate that the content of soluble ash in the organic fraction is in the range of 2 to 4 percent for fibric materials, 5 to 7 percent for hemic, and 8 to 12 percent for sapric, with the respective higher values of each range being for the more decomposed members of the class. For example, if a hemic material contains 50 percent mineral material, and a 25 percent calcium carbonate equivalent on the ovendry weight basis of the sample, the various fractions of mineral material might be partitioned approximately as 3 percent soluble ash, 25 percent calcium carbonate equivalent, and 22 percent extraneous noncarhonate. (The value of 3 percent is used because the material contains only 50 percent organic matter.)

5. Water Content at Saturation

The water content at saturation, though not a precise measurement, is related to degree of decomposition, bulk density, and content of mineral matter. We determine this as follows, We use a metal box that is 2 inches long, 2 inches wide, 7/8 inch deep, with a bottom of 20 mesh screen and a lid. Place a thick filter paper on the screen (Whatman No. 50 or thicker) and fill the box three-fourths full with organic soil material as received from the field. The lid in placed on the box and immersed in water for about 12 hours. The box is removed from the water and placed in a "humidity box" for 2 to 4 hours to allow free water to drain from the sample. The "humidity box" is watertight and filled about one-half full of water. A coarse screen is suspended above the water level. The weight of the saturated sample is obtained. The sample then is dried to constant weight at 100 to 110 C. Results commonly are expressed on the basis of ovendry weight. Water content of sample as received also is computed. Content of water also may be expressed on the saturated weight basis and on the volume basis if bulk density has been determined previously.

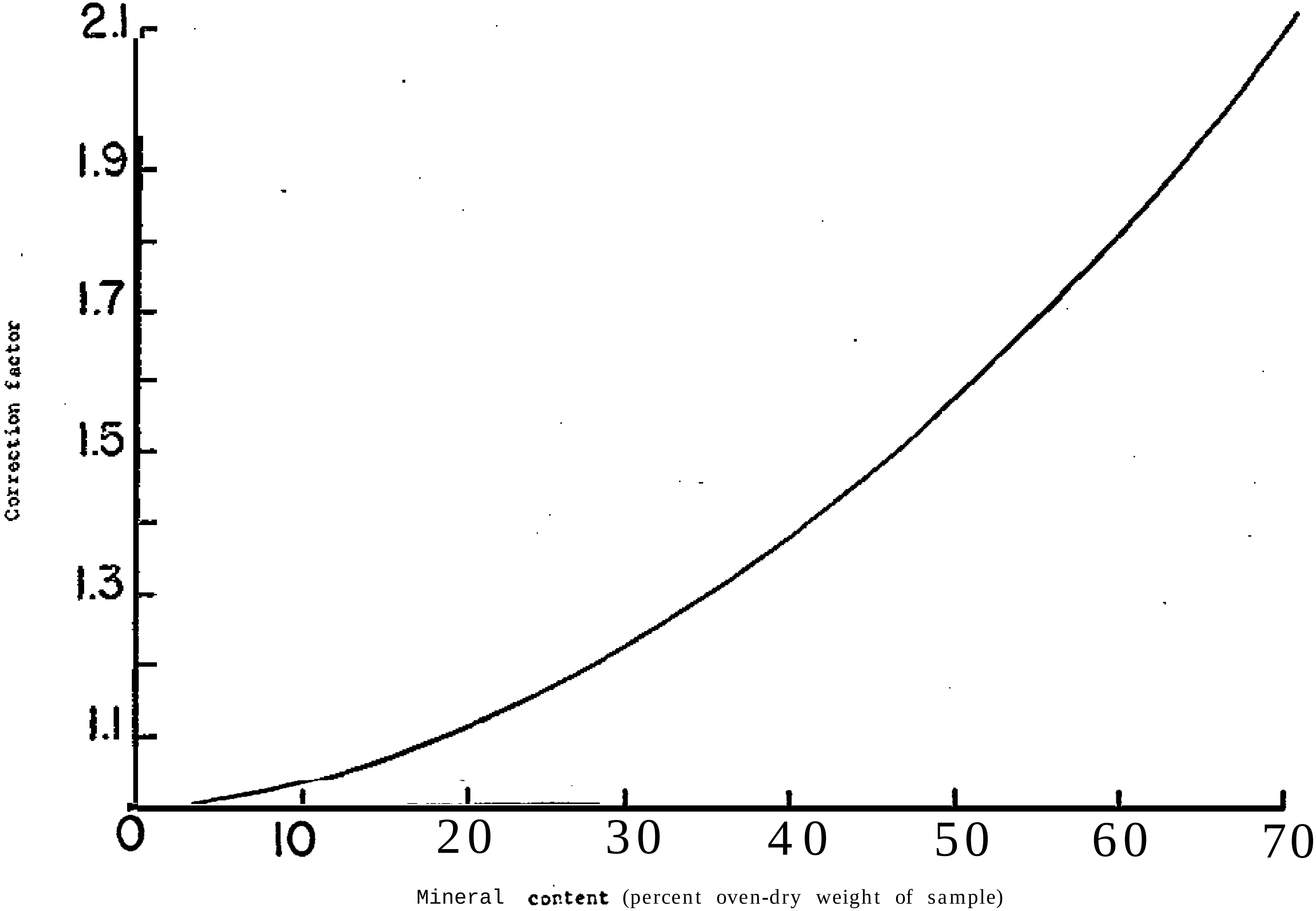


Figure I.--The relationship between the content of mineral material and a correction factor for converting the content of fiber on the basis of oven-dry weight to a percent of the volume. To estimate fiber on the basis of volume, multiply the percent fiber on the basis of oven-dry weight by the correction factor. This factor was derived from data obtained on materials containing essentially no free carbonates. Our meager data on samples containing appreciable free carbonate indicates that to 0.1 should be added to the correction factor.

FIELD TESTS FOR ORGANIC SOIL MATERIALS

February 8, 1971

To follow are tests on organic soil material, adaptable to the field office, for the determination of the color of a pyrophosphate extract fiber percentage and the pH in 0.01 M $CaCl_2$. There is a question regarding the reliability and significance of the Calgon dispersion (unrubbed fiber test) and how it relates to the field estimate of the unrubbed fiber percentage. The tests are presented for evaluation and commentary.

It is not practicable in the field to base these determinations on a dry sample weight. Hence, the volumes of moist soil material are employed. The specific Volume of the moist soil material depends on the packing operations. It is therefore important that the packing be standardized in order to obtain comparable results among different soil scientists.

MATERIALS

water
Tap water is satisfactory unless sufficiently colored to affect the pyrophosphate color test.
Solid sodium pyrophosphate, 2 mm.
Our experience is limited to the hydrate, $Na_4P_2O_7 \cdot 10 H_2O$. Air-drying makes it easier to grind the sodium pyrophosphate.
Calgon (use of trade name does not imply endorsement)
$CaCl_2$ solution, 0.015 M
Sample Containers
30 cm (1 oz) plastic condiment cups with plastic lids (Thunderbird Container Corporation, El Paso, Texas), No. 1 Poly-Co" containers (Richards Manufacturing Company, Van Nuys, California), 1 pint plastic nestable containers (Dixie Gourmet No. TF16-11, American Can CO.). Collection and storage of the field sample may be done in various ways. The field sample may be collected in plastic bags and the subsample transferred after mixing thoroughly, Into a No. 1 or No. 2 Poly-Co" container or a condiment cup. Alternatively, the mixing may be done at the sample site and only a small subsample placed in a condiment cup or to a Poly-Con container for transport to the field office.
Liquid Dispenser
Nalgene automatic constant volume pipettor, 3-ml capacity, modified to a 4 ml by inserting a piece of plastic tubing into the end of the inlet stem. Cap with the rubber bulb from a medicine dropper to reduce leakage in transit.
Chromatographic paper strips, 1/2 (minimum) by 3 cm
Schleicher and Schuell No. 470 A-3 available in 1-1/2 by 23 inch pieces.
Other papers may be equally satisfactory.
Absorbent Paper
A thick soft chromatographic paper cut into squares roughly 10 cm on an edge is satisfactory for a field kit. Any absorbent color-fast blotting paper or heavy towelling should be satisfactory.
Measures
Tablespoon and 1/2 and 1/8 teaspoons, half syringe'. A 6-ml plastic hypodermic syringe with the body sliced in two longitudinally to make a half cylinder measuring device. Actual volume is 1/2 that indicated on the syringe. The soil material can be removed more readily from a" oblong than an elliptical spoon.
Sieve
No. 100-mesh, 3-inch diameter.
Egg beater
Spatula
4-inch, plain; shape the end to conform with the contour of the l/Z-teaspoon measure.
Wooden coffee stirrers
Marking pencil
Munsell Color Book--10YR and 7.5YR pages required

TESTS

Pyrophosphate Test

Present Status: **Early** results of pyrophosphate **tests** were **somewhat erratic** among workers, mostly **because procedures** were **not standardized. The test** outlined below has give" reproducible results that correspond **well** to pertinent **taxa** in the classification system, **namely,** separation of **fibric, hemic,** sapric, and **coprogenous** materials.

Fiber Tests

Present status: The **classification** of **Histosols** has been based in part upon proportion of organic matter that is fiber **(<0.015 mm)** in the natural condition and the proportion of fibers that are **resistant** to breakdown. The two are termed """rubbed" and "rubbed" fiber, respectively.

Attempts have bee" **made** to devise field and/or laboratory tests to **estimate** unrubbed and rubbed fiber **under** standardized and, hopefully, reproducible procedures.

Testing for ""rubbed fiber presents difficulty because of the nature of the material itself. Operations that remove "on-fibrous **material** also remove non-resistant **fibers.** The test outlined below is designed to give numbers that approximate unrubbed fiber **values.** Residue volumes **are** measured following a gentle but standardized procedure. Residues likely include **some** "on-fibrous material and exclude non-resistant fibers. Removal of **mineral material** is more critical in some cases than others. The test needs to be evaluated **in a** year or two, after results from a number of samples are **available.**

The test for rubbed fiber outlined below is reproducible and correlates rather closely with visual field estimates of rubbed fiber. Evidence to date suggests that the rubbed fiber boundary between **hemic** and sapric **materials** should be higher than 10 percent - values of 15 or 20 percent rubbed fiber should be considered.

Field samples collected for use in determining field tests should be from the dominant kind of organic **material** within the layer described **and** from the **same** layer on **which** field estimates of rubbed and unrubbed fiber percentages were determined. Take sufficient **subsample** to fill **a Poly-Con** No. 2 container. (About **50** cm'.)

PROCEDURE

Preparation of Sample

Place rounded 1 tbsp. of wetted field sample on a piece of absorbent paper. Smear the soil material over the absorbent paper to **mix** and to bring in contact with the paper. Alternatively, the absorbent paper may be rolled around the sample **and water** removed by squeezing with a second piece of absorbent paper. Continue **desorption** until the soil material' no longer glistens but is still very moist.

If not done previously, visually estimate the rubbed and unrubbed fiber percentage.

Pyrophosphate Color Test

1. Place a heaping **1/8 tsp.** (1 **g**) of the pyrophosphate and 4 'ml of water into **a 30** ml plastic **container.** Allow to equilibrate a few minutes. Pack a **1/2** tsp. **or** a half-syringe adjusted to 5 cc capacity level full with moist soil material. In filling, pack **firmly with a** spatula but avoid expressing water. Transfer soil material cleanly to the container which holds the pyrophosphate solution. **Mix** thoroughly using a coffee stirrer; cover and let 'stand overnight.

2. **Mix** again thoroughly. Insert the strip of chronatographic paper vertically **about** 1 **cm** with tweezers. Let stand until the paper strip has wetted to the top (may stand longer if cover closed). Remove the paper test strip with tweezers. and tear off and discard the portion with soil adhering. Place the strip on a piece of blotting paper (i.e. 10 cm square) **and** press **gently** with **tweezers** to **make** firm contact. Remove with **tweezers** and compare color **on** side next to blotting paper with **Munsell** color **charts.** If successive samples are blotted systematically, a comparative record is obtained on the sheet of blotting paper.

Calgon Dispersion - (Approximate unrubbed fiber values)

1. Pack a 1/2 tsp. or a half-syringe adjusted to 5 cc capacity level full with moist soil; transfer all of the soil material to a pint container using tap water from a cold water faucet.

2. Add about 1.5 g (half-teaspoon level full) to commercial Cslgon. Bring to 400 ml volume with cold tap water and stir with an egg beater for one minute at about 90 revolutions of the handle per minute. Let stand overnight.

3. After standing over night stir several times with a coffee stirrer. Transfer to a No. 100-mesh sieve and wash with cold tap water from a faucet adjusted to deliver about 400 ml of water in 5 seconds until the water passing through the sieve appears clean. Move the sieve to direct the stream of water onto the sample. Transfer the sample to absorbent paper by inverting the sieve sharply on a hard surface. (Gently police the sides of the sieve with wooden coffee stirrer or a finger. Do not police sieve'.) Withdraw water until the sample no longer glistens. Determine volume by packing in a half syringe or in a 1/8 teaspoon measure. Report to nearest 1 percent if use half syringe. Each 1/8 teaspoon represents 25 percent of the original packed volume; report to nearest 5 percent.

Rubbed Fiber Percentage

Piece sample from Calgon dispersion test in a No. 100-mesh sieve. Rub sample between thumb and fingers under a stream of water until water passing through sieve is clean. Clean fibers will roll between the thumb and fingers rather then slide or smear. Use half syringe to measure volume as described in step 3 under "Calgon dispersion".

DISCUSSION

A sheet for recording the various data is attached. Also attached is a diagram of a 10YR hue Munsell color page showing the limits exployed in the comprehensive soil taxonomy system. These limits, as taken from Soil Taxonomy, are es follows:

Fibric materials with fiber contents comprising less than 3/4 of the organic volume after rubbing must yield a sodium pyrophospharc extract color on chromatographic paper that is 7/1, 7/2, 8/1, 8/2, or 8/3.

Sapric soil materials must yield a sodium pyrophosphate extract color on chromatographic paper that is below or to the right of a line drawn to exclude 5/1, 6/2, and 7/3 on 7.5YR or 10YR hue.

Coprogenous earth comprises soil materials that are nearly devoid of fragments or pieces of dead plant tissues that yeild a sodium pyrophosphate extract on chromatographic paper that is higher in value and lower in chroma than 10YR 7/3.

In reference to the pyrophosphate color test, some investigators indicate that the sample if originally dry should be moistened several hours before initiation of the test. For standard determinations, the paper strip is inserted after the mixture has stood overnight; but verification that the color expression exceeds certain limits may be made after 15 to 30 minutes. The length of time the paper strip stands in the pyrophosphace solution after wetting has been completed is not critical if the container is closed. The literature suggests that the effectiveness of the pyrophosphate solution in solubilizing organic matter increases with rising temperature. Colors of extracts from diverse soil materials were compared over a range in temperature. The difference in color between 60 and 90°F. was too small for consistent detection.' If the maximum temperature of the mixture during equilibration is outside of this range, the temperature should be recorded to provide a guide for interpretation of the colors.

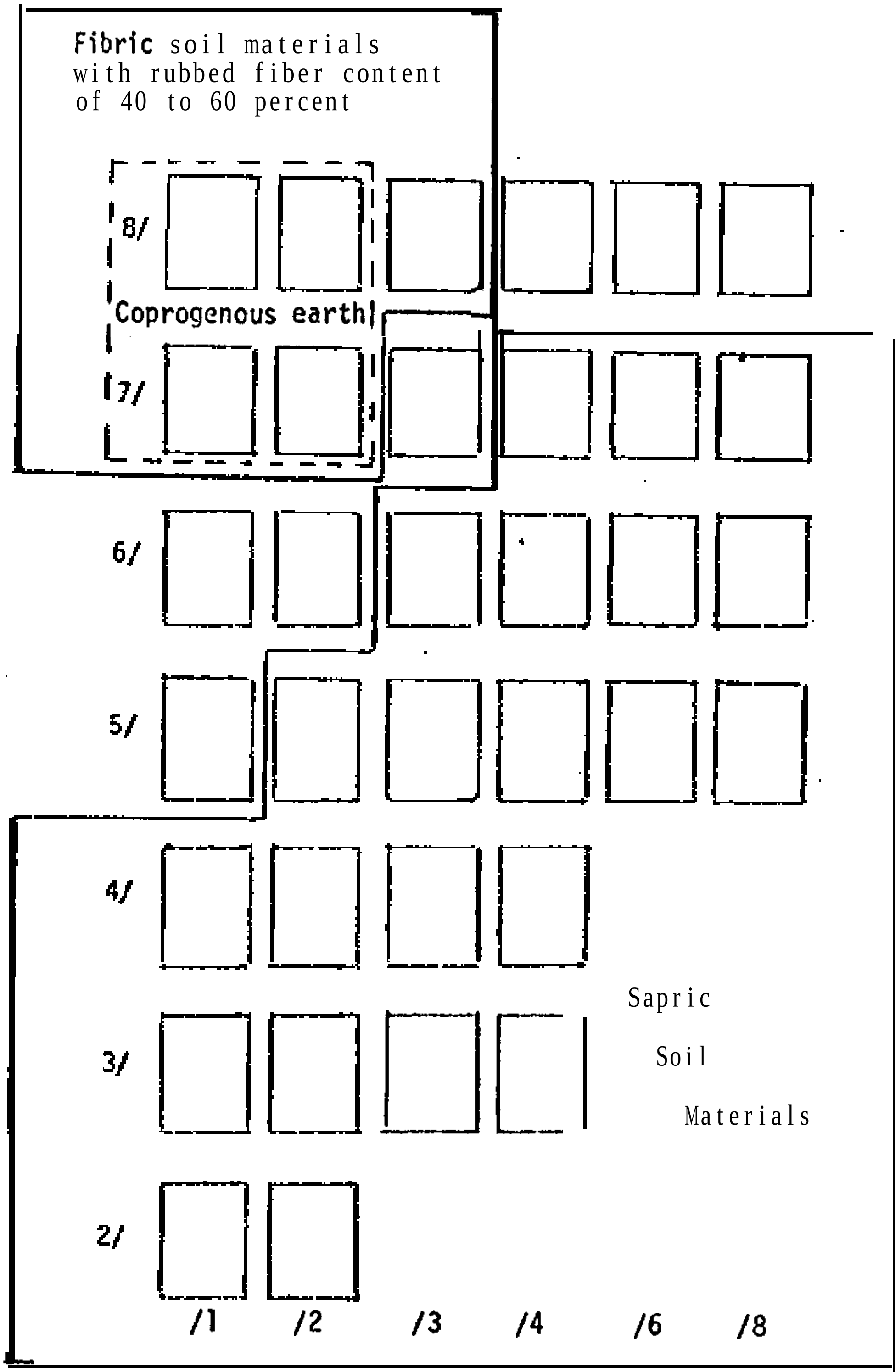
The base for the fiber tests is the whole soil material, inclusive of the inorganic portion, at a roughly defined moisture tension.

The pH in 0.01 M $CaCl_2$ may be run on the sample as prepared for determination of the color of the pyrophosphste extract. Four ml of 0.015 M $CaCl_2$ added to one-half teaspoon of packed. moist organic yields of final concentration of about 0.01 M $CaCl_2$. When using the pH paper the best procedure is to place one side of the paper against the sample just long enough to moisten it through and then read color.

Prepared by:

Warren C. Lynn, Research Soil Scientist,
SCS, Soil Survey Laboratory,
Lincoln, Nebraska

William E. McKinzie, Assistant Principal Soil Correlator
Midwest Region, SCS
Lincoln, Nebraska


Fibric soil materials
with rubbed fiber content
of 40 to 60 percent
8/
Coprogenous earth
7/
6/
5/
4/
3/
2/
/1
/2
/3
/4
/6
/8
Sapric
Soil
Materials

DATA SHEET ORGANIC SOILS

Sample	Layer	Depth	pH $CaCl_2$	Sodium Pyrophosphate Color Test	Percent Fiber			
					Field Estimate		Field Test	
					Unrubbed	Rubbed	Unrubbed	Rubbed

CRITERIA FOR CLASSIFICATION AND NOMENCLATURE OF MISCELLANEOUS LAND TYPES AND DEFINITION OF TOPSOIL USED TO RESURFACE CUTS AND FILLS

Committee 8

This committee is new but its subject matter has been discussed by other committees for several years. The 1969 Committee on "Made soils" recommended that an inventory be made of names of miscellaneous land types correlated in recent years, and that definitions be developed for all that are not defined in the Soil Survey Manual.

The Soil Survey Manual says miscellaneous land type names are to be used for areas "that have little or no natural soil, ...or where... it is not feasible to classify the soil." In context, this meant that miscellaneous land type names were to be used for areas for which series names were inappropriate. Many land types, such as Alluvial Land, consist mostly of soil. A few do not.

The inventory of miscellaneous land type names was compiled by the office of the Director, Soil Classification and Correlation. It shows that 86 varieties or phases of Alluvial land, 3 of Alluvium, and 9 of Riverwash have been correlated in recent years. It also shows that about 725 names can be grouped under about 93 major headings comparable to Alluvial Land. One page of the listing of names far Alluvial Land is attached as a sample of the inventory.

The Southern Regional Committee compiled a list of miscellaneous land types that had been used in their region. It recommended that miscellaneous land types not be used for areas of soil, but rather that use be made of classification units using nomenclature in categories above the series level.

The Northeast Regional Committee compiled a list of land types and definitions that have been used in recent correlations in the region. Fifteen phases of Alluvial Land were correlated in 49 soil surveys in recent years.

The Western Regional Committee dealt with Made, Disturbed, and Shaped soils. It recommended a trial of the following:

A PROPOSED KEY FOR CLASSIFICATION OF MADE LAND AND DISTURBED OR SHAPED SOILS

I. With less than 50 percent of earthy material in the control section, or with a cover of earthy material less than 20 inches thick. Made land.

(Naming nap units - If more than 200 acres, mapping unit should be named "Made land" and described as a miscellaneous land type. If less than 200 acres use a special mapping symbol. In most survey areas made land occurs in small bodies that can be shown best by special symbols.)

II. With more than 50 percent of earthy material in the control section, and with a cover of earthy material more than 20 inches thick.

A. Without fragments of diagnostic horizons, or if diagnostic horizons are present they have been interrupted in over 65% of area or are buried more than 20 inches deep.

1. With heterogeneous earthy material having a wide range in textures, 1/ other characteristics or both. Cut and fill land or Fill land.

(Naming map units - modifiers to indicate the nature of the material may be added to the phrase "Cut and fill land" or Fill land".)

1/ Strongly contrasting particle size classes in family groupings may be a guide for "wide range in textures."

2. **With** homogeneous earth material having a narrow range in textures, and without diagnostic horizons - Entisols. Classify at the lowest category possible, preferably at the series level.

(Naming map units) -

(a) Map units should be named as phases of soil series. Disturbance of such soils commonly will not change the soils appreciably, and they may be named the same as the original series.

(b) If an existing series cannot be identified, and the material is extensive, a now series should be named and described. Map units should be named as phases of soil series.

(c) If the material is not extensive, the soil may be named as a variant of an existing series. Map units should be named as phases of the soil variant.

B. With fragments of diagncstic horizons. Original diagnostic horizons have been mixed by ripping, deep plowing, or other operations, but not to the extent that fragments or parts of horizons can no longer be identified or are buried more than 20 inches. Classify in the suborder - Arents.

No great groups or subgroups have been defined in Arents, but family nomenclature including texture, mineralogy, reaction, and temperature may be added to the classification.

(Naming map units) -

1. If the soils are uniform enough that most pedons have characteristics within the range of a series, name and define as a soil series. Hap units should be named as phases of soil series.

2. If the soils are not uniform and pedons have characteristics that are tco wide to be appropriate for a series, name the mapping unit at some level above the series category, using the suborder name, Arents, as part of the name.

(a) If the original soil series, before alteration, can be determined with a reasonable degree of certainty, the series name may be used as part of the mapping unit name, if this will serve a useful purpose. Example: Argidic Arents, Elijah soil materials.

(b) If the original soil series cannot be identified, modifiers may be used to indicate the kind of diagncstic horizons present and the general texture class. Example: Argidic Arents, loamy.

C. With diagnostic horizons that have not been destroyed, or interrupted, over less than 35% of the area, or buried more than 23 inches. Classify in appropriate orders at the lowest category possible, preferable as a phase of a soil series.

(Naming map units) -

Name as phases of soil series. Example: Elijah silt loam, leveled phase.

This Committee agrees that these proposals should be tested, but recommends that the scope be broadened to include all of the miscellaneous land types that consist of soil, and that miscellaneous land types be restricted to areas of "not-soil." This suggestion would change the Western proposal II Al to introduce the name of a phase of a taxon at the family or higher level but at the lowest possible category. Obviously a series name could not be used for II Al.

Under this proposal, areas of not-soil would be mapped and named as a miscellaneous type alone or as a complex, or as an undifferentiated unit with soil or with other miscellaneous land types, following the conventions used for naming of soils. Thus, a unit named as a miscellaneous land type such as Hock outcrop could have up to 25 percent of soil if the soil were very shallow to rock, or up to 15 percent of soil if the soil were moderately deep or deep to rock. If areas of soil constituted 30 percent of the area, the name would have to reflect the presence and nature of the soil as well as the rock.

Areas that are mostly soil and that for some reason cannot be named far a phase of a series would be named for a phase of a taxon or taxa in the lowest category that provides an accurate name. This might be an order or a family, or any intermediate category.

We should keep and define <u>only</u> the following miscellaneous land types:

<u>Badland</u> is steep or very steep nearly barren land, ordinarily not stony, broken by numerous intermittent drainage channels. Badland is most common in semiarid and arid regions, where streams have entrenched themselves in soft geologic materials. Local relief generally falls between 25 and 500 feet. Runoff is very high, and geological erosion active. Badland has practically no agricultural value, except for small areas of soil with some value for grazing that may be included in the mapping unit.

<u>Beaches</u> are sandy, gravelly, or cobbly shores washed and rewashed by waves. The land nay be partly covered with water during high tides or stormy periods. Roaches support little or no vegetation and have no agricultural value, although they may be sources of sand and gravel.

<u>Blown-out land</u> consists of areas from which all or most of the soil material has been removed by wind--a condition resulting from an extreme degree of soil blowing or wind erosion. The areas are shallow depressions that have flat or irregular floors formed by some more resistant layers, by an accumulation of pebbles or cobbles, or by exposure of the water table. Some areas have a small proportion of hummocks or small dunes. The land is barren, or nearly so, and useless for crops. Small areas of <u>Blown-out</u> land are often called "blowouts" and are shown with symbols.

<u>Coquina land</u> consists of cemented shell fragments, mainly from the coquina clam but with lesser amounts from the conch, oyster, and other shell-bearing mollusks and coral. This land is not useful for crops but commonly supports a few trees. The material has been used for building and for roadbeds.

<u>Dumps</u> are areas of smoothed or uneven accumulations, or piles, or waste rock incapable of supporting plants because of particle size or toxicity. A subclass is <u>Mine dumps</u>--areas of waste rock from mines, quarries, and smelters. Commonly, dumps are so closely associated with pits that complexes or undifferentiated units such as <u>Pits and dumps</u> or <u>Mine pits and dumps</u> are needed.

<u>Dune land</u> consists of ridges and troughs that are composed of sand-sized particles that are virtually devoid of vegetation, and that shift with the wind. Sand dunes that have been stabilized by vegetation should be named as a kind of soil rather than as dune land.

<u>Lava flows</u> are areas covered with lava. In humid regions the flows are of Holocene age, but in arid regions they may be older. Most have sharp jagged surfaces, crevices and angular blocks characteristic of lava. A little earthy material may have blown into a few cracks and sheltered pockets, but the flows are virtually devoid of plants except for lichens.

Oil-waste land includes areas where liquid oily wastes have accumulated. This miscellaneous land type includes slush pits and adjacent uplands and bottoms affected by the liquid wastes, principally salt water and oil. The land is virtually barren, although some of it can be reclaimed.

Pit_ are open excavations from which soil and underlying materials have been removed and which are either rock lined or too toxic to support plants. Subclasses would include Mine pits and Quarries. Commonly, pits are closely associated with dumps, and complexes or undifferentiated units, such as Pits and Dumps, may be needed.

Quarries (*see* Pits)

Rock outcrops consists of exposures of bare hard bedrock. Although very rarely needed, subclasses can be named according to the kind of rock materials, including: Chalk outcrop, Limestone outcrop, Sandstone outcrop, and Shale outcrop. Commonly, areas of Rock outcrop are too small to be delineated on the map and are shown by symbols. On the other hand, the areas can be extensive, broken by small spots with soil.

Rubble land includes areas of stones and boulders, virtually free of vegetation except for lichens. These are commonly at the base of mountain slopes and formed in Pleistocene or Holocene time.

Salt flats consist of low lying areas in arid climates, primarily where lakes existed during the Pleistocene. Evaporation of the lake left a layer of salt at the surface.

Scoria land consists of areas of slaglike clinkers and burned shale and fine-grained sandstone characteristic of burned-out coal beds.

Slickens are accumulations of fine-textured materials separated in placer-mine and ore-mill operations. Slickens from ore sills consist largely of freshly ground rock that generally has undergone chemical treatment during the milling process. Such materials may be detrimental to plant growth but are usually confined in specially constructed basins.

Urban land is land so altered or obscured by urban works, structures, and earth moving that identification of soils is not feasible. Soil boundaries should be extended into urban areas wherever it is possible to do so with reasonable accuracy. In areas where houses have lawns and gardens, urban land is commonly used as a part of a complex name, such as Beltsville-Urban land complex.

The 1969 Topsail National Committee on Criteria for Classification and Nomenclature of Made Soils and Definition of "Topsoil" Used to Resurface Cuts and Fills made the following recommendations for the definition for' topsoil:

1. Adopt a definition which limits the meaning of topsoil to soil material used to topdress roadbanks, lawns, etc. Exclude synonymous meanings such as surface soils (sic), Al, and Ap horizons.

2. TOPSOIL. -- Mineral soil or similar earthy material used as top-dressing for house lots, grounds for large buildings, gardens, road cuts, or similar areas. The earthy material has favorable characteristics for production of desired kinds of vegetation or can be made favorable by treatment and lacks substances (in amounts) toxic to plants.

3. Encourage users of topsoil to state specifications for the material which they plan to use for topsoil. Example: texture, coarse fragment content, organic matter content, exchangeable sodium percentage, and reaction. The proposed definition given above is in general terms. For this reason, specifications are needed to meet locally intended use.

4. Encourage Regional Committees to develop a check list that might be used in developing specifications for particular uses of topsoil.

This committee believes the proposed definition is satisfactory and has no better substitute to offer. The original proposal of the committee was modified appreciably after the discussion in the conference.

Recommendations:

1. Miscellaneous land type names should be used only for areas of not-soil. If this is done, numbers of names may be vastly reduced.
2. Areas of soil that have previously been named as miscellaneous land types because series names were not appropriate should be named as taxa in the lowest category that provides an appropriate name.
3. The committee should be discontinued.

Discussion:

During the discussion of the report., suggestions were made for modification of the definition of badlands, and for the addition of dune land to the original list.

It was suggested that a better name than miscellaneous land types was needed for the revised Manual. The committee suggests that the phrase "Areas with little soil" be substituted.

Members - Committee 8:

L. J. Bartelli, SCS
Fort Worth, Texas

F. J. Carlisle, SCS
Hyattsville, Maryland

R. C. carter, SCS
Jackson, Mississippi

Richard Huff, SCS
Berkeley, California

R. L. Marshall, SCS
Syracuse, N. Y.

J. E. McClelland, SCS
Lincoln, Nebraska

J. D. Rourke, SCS
Upper Darby, Pennsylvania

J. M. Williams, SCS
Portland, Oregon

Guy D. Smith, Chairman
SCS
Washington, D. C.

"Miscellaneous Land Types"

Name	Listed by:
ALLUVIAL LAND	SSM-Dir-NE-S-K&W [1/]
Alluvial lands	MW
Alkali alluvial land	Dir W
Alluvial land, bouldery	Dir-NE
Bouldery alluvial land	SSM-Dir
Broken alluvial land	Dir S-MW
Alluvial land, channeled	MW
Alluvial land, clayey	W
Clayey alluvial land	Dir S-W-W
Wet clayey alluvial land	Dir
Cherty alluvial land	Dir MW
Alluvial land, coarse	Dir MW
Alluvial land, cobbly	Dir-NE-S
Ccbbly slluvial land	SSM-Dir S W
Ccbbly alluvial land, frequently flooded	W
Alluvial land, frequently flooded	MW
Alluvial land, frequent overflow	Dir MW
Alluvial land, gently sloping	MW
Alluvial land, gravelly	Dir-NE
Gravelly alluvial land	SSM-Dir S W
Alluvial land, loamy	Dir-NE MW
Loamy alluvial land	Dir S-MW-W
Loamy alluvial land, dark surface	W
Loamy alluvial land, depressed	Dir S
Loamy alluvial land, gravelly substratum	W
Loamy alluvial land, moderately wet	W
Loamy alluvial land, moderately saline-alkali	Dir W
Alluvial land, loamy, nearly level	MW
Loamy alluvial land, poorly drained	Dir MW
Loamy alluvial land, strongly saline	Dir W
Loamy alluvial land, wet	Dir MW
Wet loamy alluvial land	W
Loamy wet alluvial land	W
Local alluvial land	Dir S
Local Cherty alluvial land	Dir S
Local alluvial land, level	Dir S
Mixed local alluvial land	Dir S
Mixed wet local alluvial land	SSM-Dir
Local alluvial land, moderately wet	Dir S
Local alluvial land, nearly level	Dir S
Local alluvial land, phosphatic	Dir S
Local alluvial land, wet	Dir S
Local wet alluvial land	Dir S
Alluvial land, marl substratum	Mr-NE MW
Alluvial land, medium	Dir MW
Alluvial land, moderately well drained	Dir S
Alluvial land, moderately wet	Dir S
Alluvial land, mixed	MW-W
Mixed alluvial land	SSM-Dir-NE-S-R&W

[1/] SSM-Soil Survey Manual; Dir-Directors file; NE-Northeast, S-South, MW-Midwest, and W-West RTSC lists respectively.

ATTACHMENT

REPORT OF THE COMMITTEE ON SOIL MOISTURE AND TEMPERATURE
IN RELATION TO SOIL CLASSIFICATION AND INTERPRETATION

The Soil Survey Manual is under revision. This committee has devoted its efforts to the formulation of ideas that may be helpful in preparing the discussions of soil temperature and soil water for the revised Manual.

1. Regional Committee Activities

The four regional committee reports are reviewed with emphasis on aspects that may be important in revision of the Manual.

1.1 Northeast

The committee, "Soil Moisture," met under the chairmanship of Dr. D. E. Hill. The report contains a discussion of estimation of the soil moisture regime from weather data. These ideas are pertinent to the guidelines that may be established in the revised Manual for the description of the water regime of soils and computations of the moisture regime from weather data. An abridgment of this discussion follows.

"Several members of the Northeast Committee were concerned with the basic objective of using weather data to predict the soil moisture regime. The use of weather data would be inferior to actual measurement of soil moisture because of the many interrelated factors affecting (1) the capability of the soil to store water, (2) the capacity of mother nature to supply water, and (3) the capability of plants to utilize it.... Despite our cautious natures we felt that the Regional and National Committees should develop a classification of moisture regimes that could be used to quantify moisture in the unsaturated zone occupied by plant roots. A minimum goal would be to develop a system that could be used in making statements in Official Series Descriptions based on the capacity of the profile to a specified depth to store moisture between specified tensions.

"Our first attempt was to quantify the moisture regime during the growing season in the Northeast, a period from May 15 to September 15. We narrowed the segments to moisture contents at which (1) the plants were not under stress and (2) the plants were under stress. We were reluctant to place a value at the point Of stress vs no stress in the soil because stress is often placed on the plant by atmospheric conditions (e.g., hot dry winds on a sunny day vs cool moist winds on a cloudy day). But, for the sake of argument, we tentatively accepted a tension of 10 atmospheres.... The classification must include not only a description of the length of moisture stress periods but also when these periods occur during the growth cycle....

"With knowledge of moisture release and available moisture holding capacity in any soil to a given depth, one could estimate the moisture content of the soil at the stress point. A daily bookkeeping method can be developed using rainfell as a credit (adjusting for runoff and flowthrough in heavy rains) and Using one-half pen evaporation as a debit (except in July and August "he,, the full pan evaporation would be used). In the absence of pan evaporation records, evapotranspiration estimates can be 0.1 inches per day during May, June, and September, and 0.2 inches per day during July and August. From summaries Of long-term weather records, one could predict the probability of drought classes in any segment of crop growth and could then make useful interpretations about any selected crop."

The regional committees were asked to make recommendations on the organization and topics to include in a publication on the soil moisture regime that would be similar to SCS-TP-144, "Soil Temperature Regimes--Their Classification and Predictability." The outline to follow was prepared. Both this outline and the one proposed by the Southern committee stress the factors that determine the moisture regime.

I. Introduction--definition and objectives of a report on the predictability of soil moisture regimes.

II. Internal factors--soil moisture regime as affected by:

A. Soil texture (including coarse fragments).

1. Particle-size distribution and moisture holding capacity.
2. Lithologic discontinuity in texture.

B. Soil structure (including fragipans).

C. Water tables (true and perched).

D. Soil organic matter.

III. External factors--soil moisture regime as affected by:

A. Position on landscape.

B. Slope, runoff, and run-on.

C. Climate.

1. Precipitation (quantity and seasonal distribution).
2. Temperature.
3. Evaporation potential (relative humidity, wind speed, and net radiation).

D. Geography.

1. Elevation and aspect.
2. Distance from oceans and large inland bodies of water.

IV. Plant factors--soil moisture regime as affected by:

A. Cultivated row crops.

B. Pasture and range.

C. Trees (through fall and stem flow).

D. Rooting depth.

1.2 Northcentral

The committee, "Soil Moisture and Climate in Relation to Soil Classification," met under the chairmanship of Dr. T. E. Fenton.

Dr. Scrivner discussed the concept of "minimum field content" of water. This is the lowest water content (highest tension) of a given depth over the course of the year. Sail temperature data were discussed for the region. The difference between soil temperature and air temperature ranges from 0 to 6" F. The problems of inferring the water table regime from soil morphology were reviewed. As an outgrowth of a discussion of the need for a publication on soil moisture to parallel SCS-TP-144, "Soil Temperature Regimes--Their Characteristics and Predictability," the suggestion was made to have a symposium at the 1971 ASA meetings on the field soil moisture regime. Arrangements are in progress for such a symposium.

1.3 Southern

The committee, "Soil Moisture and Temperature," met under the chairmanship of Dr. R. B. Daniels. The committee prepared a" outline for a publication on soil moisture to parallel SCS-TP-144, which is reproduced below.

(1) Relations between soil morphology, especially color, and water-table levels.

1a. Effect of dissolved oxygen and Eh/pH relations.
1b. Effect of micro topography--short periods of saturation by runoff may affect morphology more than average Water level.
1c. Effect of deep summer or fall water table on development of Aquults and Aqualfs.
1d. Effect of shallow winter water table on development of Udults, Udalfs.

(2) Relations between landscapes and water tables.

2.1 Effect of stratigraphy--permeable vs impermeable underlying formations.
2.2 Effect of landscape dissection on water table depth and duration.
2.3 Relations between water-table depth and soil properties.
2.31 Physical--clay content of B, A2 horizon thickness, B horizon morphology.
2.32 Chemical and mineralogical properties--Al saturation, clay mineral kinds and amounts.

(3) Soil moisture regimes above the water table.

3.1 Yearly changes in moisture content by depth.
3.11 Forested Udults, Aquults, Aquods, Aqualfs, and Udalfs, and their cultivated counterparts.

(4) Soil moisture regimes from West-Texas or Oklahoma to the Atlantic Ocean and its relation to climatic factors.

(5) Methods.

5.1 Wells, equipment and measuring frequency used in water table studies.
5.2 Equipment, its limitations and validity of measurement for studying soil moisture regimes above the water table.

1.4 Western

The committee, "Climate in Relation to Soil Classification and Interpretation," met under the chairmanship of Dr. R. J. Arkley. The committee discussed the encoding of soil temperature information collected periodically at a site. An instruction sheet for coding the information describing the site and listing the temperature data has been prepared. The 1969 National Climate Committee proposed a form for collection of soil temperature information. These efforts pose the question for revision of the Manual as to whether instructions should be given for the standardized collection of soil temperature data. The format for the pedon data record does provide much of the information required by the Western form for encoding temperature data. But there are differences. For example, the Western temperature code calls for more information on vegetation, The pedon data record codes for cyclic soil properties have not been completed.

2. National Committee Activities

2.1 Soil temperature

Members of the national committee were asked to assess SCS-TR144, "Soil Temperature Regimes--Their Characteristics and Predictability," as the source document for discussion of soil temperature in the revised Manual. Mr. Clayton and Dr. Baler considered the publication from the viewpoint of Canadian experience. They have the following comments.

"For the purpose of the Manual, TP-144 is reasonably well prepared and is adequate for consideration of the most important parameters that affect soil temperature regimes.

"We feel, however, that the examples given are not perhaps fully adequate to characterize the temperature regimes in the colder continental boreal, cryoboreal and pergelic climates. In this regard, we feel that the approach we have been using to evaluate duration and degree of temperature regime above selected thresholds as expressed in days and degree merits consideration."

The Canadian approach to the description of soil climate is reported elsewhere in these proceedings and Will not be repeated. It involves definition of four periods in the year based on the soil temperature at 50 cm. Each period is characterized in respect to its length, accumulated degree days above or below the temperature on which the period is defined, and the mean soil temperature.

Support for the use of the degree-day concept comes from Dr. R. H. Rust, who is not a committee member but was contacted by the Chairman because of his interest in soil temperature. He writes:

"We wonder if some kind of accumulated soil heat units might not be useful. There ought to be acceptable correlations between accumulated heat (say, above 40" F) and nitrogen production from soil organic matter. Measured on an air temperature basis, this type of parameter is in common use in the vegetable and field canning industry."

To follow are some suggestions, observations, and questions pertaining to the discussion of soil temperature in the revised Manual:

1. SCS-TP-144 (reduced perhaps one-fourth) would, if included in the Manual, provide a very adequate discussion, both as regards the factors that determine soil temperature and measurement procedures. In passing, the paper by Franzmeier et al (SSSAP 33:755) might be substituted for the study by Cantlon to illustrate the influence of aspect in mid-latitudes. The prior question, however, is whether the Manual should contain a discussion Of the factors controlling the soil temperature regime, or be limited to measurement and the definition of some concepts.

2. The concept of degree day should be explained and examples of its use given.

3. Should a brief summary of the soil temperature criteria in the taxonomic system be added?

4. The ESSA program for collecting and publishing soil temperatures might be explained.

5. The relationship of temperature and nitrification has-been extensively studied and is very important for cold soils. It may merit a few sentences.

6. Guidelines for the presentation of soil temperature in terms of probability statements of the maximum and minimum temperatures for specific depths probably should be discussed. Dr. Rust writes:

   "Probability statements for soil temperature could reasonably be derived as we are attempting to use them in soil moisture criteria. These probabilities could be stated in terms of '7 out of 10 years the range of soil temperature at a depth of 15 (or 35, or 100) cm will be....' As our plant physiologists establish the survival temperature limits (hot or cold) for new species in a particular environment we would be in a position to 'match' their parameters, i.e., predict adaptation.

   "Probabilities of maximum or minimum temperatures at stated depths (and average moisture conditions and certain cover conditions) could be derived and ought to be useful as family criteria, if not higher."

7. The discussions of measurement of soil temperature in SCS-TP-144 profitably could be supplemented with a description of a specific installation and procedure of study that might be done in the course of a several-year soil survey. Dr. Rust has had experience with this. He writes:

   "We believe that in the course of a three-year progressive soil survey in an average county, a series of sail temperature measurements could be made that could describe, with some statistical reliability, the temperature regime at about three depths (1) seed zone--15 cm (2) mid-rooting zone of annual cereals, about 35 cm (3) rooting zone of deeper legumes, about 100 cm. An installation of three thermistor type probes would cost about $103. Several may be needed. (We have had some installed for four years.)"

8. A few words about thermometers to use, their calibration, and checking may be useful.

9. The question was raised in section 1.4 about a standard format for recording site and temperature information. Guidelines should be provided and integrated with the format called for by the national pedon data record.

10. The Canadians have developed a soil climate classification. Should the principles be discussed in the revised Manual?

2.2 Soil Water

The Chairman has prepared a tentative and incomplete discussion of soil water (appended). There are three principal sections: water state and capacity, water movement, and water regimes. The emphasis is on definition, means of measurement or estimation, and guidelines for recording and expressing information. Factors external to the soil that control the moisture regime are not discussed. Factors internal to the soil are discussed not as a group, but rather to assist in quantitative estimation. The approach differs markedly from the recommendations of the regional committees for a publication on the soil moisture regime to parallel SCS-TP-144, the publication on soil temperature. A section on water chemistry and characterization for irrigation may be advisable (eee section A4).

The appendix would, if followed, require significant changes from the present Manual and from current field practice. Three matters seem particularly significant.

1. Terms for the water status would be provided, such as "dry," "moist,""wet." These would be used both to indicate the water status of the horizon "he" described and over a period of time. Included are also terms to describe the soil in an edaphic sense, such as "accessible usable water."

2. The emphasis in water movement would be on saturated hydraulic conductivity, but classes of unsaturated hydraulic conductivity would be provided. I" present practice, the horizon of minimum hydraulic conductivity (if not at the surface) determines the placement of the soil. This emphasizes the vertical saturated hydraulic conductivity to the exclusion of the horizontal. The option of placement based on the minimum horizon would be permitted, but also more complete placements would be encouraged. Hopefully, the letter would have some relevance to lateral water movement and to infiltration. There are few data on unsaturated hydraulic conductivity. We have scant basis on which to define classes. Help is needed from specialists in the subject. Saturated hydraulic conductivity is largely controlled by the continuity of voids larger than about 0.1 mm. ""saturated hydraulic conductivity, if for a low tension, such as the 30 millibars suggested in the appendix, decreases as the volume proportion of voids larger than about 0.1 mm increases. The description Of macroscopic voids in the revised Manual should be coordinated with the approach taken to hydraulic conductivity.

3. The discussion of internal soil drainage and the drainage classes of the current Manual would be dropped. Drainage would have a restricted meaning akin to its use in soil physics and drainage engineering. Terms would be provided to facilitate transmission to the layman of the soil water concepts in the comprehensive taxonomy system. Standard guidelines for describing the water regime of a sail or soil phase would be given. The level of detail permitted would be greater than that implicit in the taxonomic placement. Classes of soil water regime, other than those implicit in the taxonomic placement, may be formulated from the descriptions of the soil water regime. These classes would be determined by the particular soils and the objectives of the publication. National classes would not be formulated.

3. Recommendations

(1) The committee should be continued.

(2) SCS-TP-144 is adequate for the basis of discussion in the revised Manual with the addition of information on the degree-day or other heat-unit concepts.

(3) The revised Manual should include a set of terms for the description of the water status of soils. These terms should be employed to give the water status of each horizon as part of morphological descriptions and for the description of the water status of soils over time.

(4) The concept of drainage should be narrowed to the processes of discharge of water or the means for effecting the removal of water. The drainage classes of the previous Manual should be dropped. New classes of the water regime beyond those implicit in the taxonomic placement should not be introduced.

(5) Classes of saturated hydraulic conductivity in the revised Manual should permit placements that are indicative of the horizontal as well as vertical water movement. Advice should be obtained from soil physicists in the Agricultural Research Service or at Universities on the establishment of classes of unsaturated hydraulic conductivity.

Committee Members:

*R. J. Arkley
*J. S. Clayton
R. B. Daniels
J. F. Douglass
J. V. Drew
*R. B. Grossman, Chairman
T. B. Hutchings

F. Newhall
H. T. Otsuki
*A. R. Southard
*M. stout
R. Ulrich
*J. M. Williams
R. D. Yeck

*Present at conference

Discussion

The presentation consisted largely of discussion of the appendix. For lack of time, there was little direct discussion from the floor of the formal committee recommendations. The committee chairman wishes to record his apologies for this. The discussion from the floor concerning the appendix is at the end of the appendix.

Appendix to Committee 9 Report

The fallowing is a provisional and incomplete discussion of aspects of soil water. It has been written to explore the subject preliminary to revision of the Soil Survey Manual. The external factors that control the amount of water the soil receives and the removal of this water have not been considered.

- Al Water State and Capacity
  - All Definition
  - A12 Measurement or Estimation
    - A121 Specific Terms
      - Al211 Accessible (Available. Usable) Soil Water
      - A1212 Dry
      - A1213 Field Capacity
      - A1214 Usable Water
      - A1215 Water Tables
    - Al22 Field Clues for Water Status
    - A123 Arithmetic Operations
    - Al24 Water Content Determinations
- A2 Water Movement
  - A21 Hydraulic Conductivity
    - A211 Definition
    - A212 Measurement or Estimation
      - A2121 Methods
      - A2122 Prediction
  - A22 Other Terminology
    - A221 Infiltration
    - A222 Percolation Rate
- A3 Water Regime
  - A31 Definition
    - A311 Soil Drainage Concept
    - A312 Taxonomic Placement
      - A3121 Technical Explanation
      - A3122 Nontechnical Terminology
    - A313 Hydrologic Soil Groups
    - A314 Standard Description
  - A32 Measurement or Estimation
    - A321 Field Studies
      - A3211 Aquic Soils
      - A3212 Non-aquic Soils
    - A322 Calculation from Weather Data
- A4(?) Water Chemistry and Characterization for Irrigation

Al Water State and Capacity

All Definition

To follow is terminology for the description of the water status or water capacity of a horizon or zone and for indicating the moisture regime over a period of time. Unless otherwise indicated the status should be applicable to half or more of the thickness of the horizon. The water status terms are in part hierarchical. Status terms that are defined more narrowly may be employed if the information is available. The actual water content should be given if known. If the horizon periodically would be high-moist, an effort should be made to reference the consistence and structure applicable to the series concept to this water state. Since the terms are not entirely mutually exclusive, more than one may be employed, as for example, "moist, water-filled." Organic soil materials have not been considered.

The utility of the subdivisions of dry and moist depend in part on the particle-size distribution. Silty materials commonly have a wider range in water content between 0.1 and 15-bar than loamy materials; hence, subdivisions of moist would have more utility for silty materials. The range of water content for dry soil materials depends on the combined clay and organic matter contents. Subdivisions of dry would not be useful for coarse loamy or sandy materials unless organic carbon exceeds the order of 5 percent. For the most part, subdivisions of dry would be reserved for clayey soil materials.

Accessible (Available, Usable) water	The additive available or usable water for horizons above 1 m. within which roots of plants adapted to a non-peraquic water regime may ramify with a repeat distance of < 10 cm.
Available Water	The difference between field capacity and 15-bar retention.
Dry	≤ 15 bar[a/]
Air-dry	Literally air dry or the equivalent field condition.
Low-dry	> air dry, ≤ 15 bar/2
High-dry	≥ 15 bar/2, ≤ 15 bar
Taxo-dry	≤ 15 bar
Field Capacity	"The lowest moisture content to which the soil may be brought by drainage alone in any reasonable time (i.e., in a matter Of days)." (Childs, 1957)
Ground Water	A true water table is present at or above the upper boundary of the horizon; or, the horizon occurs within or is coextensive with a perched water table.
Maximum Water Content	The moisture content after prolonged wetting of the soil.
Moist	> 15 bar, ≤ 0.1 bar
Low-moist[b/]	> 15 bar, ≤ (15 bar + 0.1 bar)/2
High-moist[b/]	> (15 bar + 0.1 bar)/2, 7 0.1 bar
Taxo-moist	> 15 bar
Saturated	Ground water present; or, free water present in some part and no part drier than wet; or, tension < 10 millibars desorption if sandy, 20 if loamy, and 50 if clayey; or, if finer than sandy, the water content exceeds that retained against 10 millibar desorption by fabric coated with a flexible plastic; or, the upper boundary is within 20 cm of groundwater and the soil is wet.
Taxo-saturated	Beneath the tap of the capillary fringe associated with an apparent water table.
Usable Water	The difference between two limits, the upper commonly taken as field capacity, and the lower equal to or above 15-bar retention. Both limits are dependent on the particular soil-plant-weather situation. The upper limit would be lower than a water content which would rapidly lead to oxygen deficiency for most crops if continued for several days under conditions of rapid growth (see water-filled). The lower limit would be that required to maintain the desired rate of plant growth, if other conditions were not limiting.
Water-filled	< 10% air-filled porosity.

---

a/ Here and elsewhere, the water retained at the tension.

b/ It would be preferable to have the separation between high-moist and low-moist based on tension, perhaps 0.5 bar if sandy, 1 bar if loamy, and 3 bar if clayey.

Water table

"The water table is defined to be that level in the soil at which the hydrostatic pressure of soil water is zero. If a well is dug, the water table is the level at which water stands in it, for at that level the hydrostatic pressure in the well water is clearly zero, and at the same time in equilibrium with the pressure in the adjoining soil at that level." (Childs, 1969).

To follow are definitions for the several kinds of water tables (R. D. Miller, personal communication). I" these definitions, a cased borehole would be equivalent to a piezometer and an uncased borehole to a" observation well, as these terms are used in drainage engineering (Donnan, 1957).

Apparent water table

The level at which water stands (adequate time allowed for adjustments) in an uncased borehole is the apparent water table. It may or may not coincide with the water table as defined elsewhere, and may vary according to the depth of tbe borehole.

True water table

When a cased borehole is drilled from the surface downward, the level of the bottom of the hole when seepage of water into the hole is just observed (adequate time allowed for adjustments) is the level of the water table, providing the water does not rise to a significant height above the bottom of the hole.

Perched water table

If a water table is found by drilling a cased borehole from the surface downward, and if it is observed that further deepening of the cased borehole causes the equilibrium level of water in the hole to subside or to disappear, the" the water table observed was a perched water table. Its level is designated as the level at which the water table was first encountered. A perched water table is likely to be encountered where a pervious stratum lies above a less pervious stratum.

R. B. Daniels suggests an alternative definition: A water table is found in a horizon by drilling a cased borehole from the surface downward. If this water-bearing horizon is cased and the underlying horizon or horizons have no water table, the" the water table observed was a perched water table.

Artesian water table

If, after water first appears in a cased borehole, it subsequently rises to an equilibrium level significantly above the bottom of the hole, the final level of water in the cased borehole is the level of the artesian water table,

Virtual water table

If conditions, as observed by tensiometric measurements, are as if a static water table existed at a level that can be computed from tensiometer readings, that level is designated as the virtual water table if a cased borehole fails to reveal a water table when drive" to the indicated depth. A virtual water table is likely to occur at or just below the bottom of a fine stratum that overlies a coarse stratum of "here well decomposed muck overlies peat, This has bee" termed a hanging water table.

Wet

> 0.1 bar

High-wet

> Liquid Limit

A12 Measurement or Estimation

A121 Specific terms

A1211 Accessible (Available, Usable) Soil Water

The lower boundary should not extend beneath such root-limiting contacts as lithic or paralithic material, fragipan, petrocalcic horizon, duripan, strongly contrasting change in particle-size distribution to fragmental, a zone having both a moist bulk density of 1.8 and a repeat distance for planar voids > 0.1 mm. across "he" moist of > 10 cm., or the maximum depth of a perched or a true water table that is present when the soil temperature exceeds 5" C. If less than 10 percent air-filled porosity at 15 bar water retention were a criterion for a root-limiting zone, the limiting bulk density may be calculated for various clay percentages, assuming a 15 bar to clay ratio of 0.4:

Clay %	Db
10	2.1
18	2.0
35	1.7

A1212 Dry

The 15-bar water retention may be estimated as 0.4 times the clay percentage. Maximum air-dry moisture may be taken as the clay percentage divided by 10. The relationships may break down if the organic carbon to clay ratio exceeds 0.1, if the clay percentage is below 10, if carbonate clay forms a" appreciable part of the total clay, if the clay does not disaggregate completely in the standard particle-size analysis and for soil materials that are dominated by amorphous material, in the sense that the term is used in the comprehensive soil taxonomy system. Air-dry may be estimated as equal or less than one-fourth of the 15-bar retention.

A1213 Field Capacity

The measurement of field capacity is discussed by Peters (1965). Water is added in excess of that required to "et the sample area to the desired depth. The sample area is allowed to drain for about 2 days while covered to prevent evaporation. For udic and aquic soils, the water tension commonly decreases with depth, and may reach low values within the depth of interest. For soils drier the" udic, the initial tension more commonly would be high. A higher tension "ear the bottom of the wetted zone acts to decrease the water content at field capacity. Field capacity tends to have two differing meanings dependent on the moisture regime of the soils. Where udic and aquic soils predominate, field capacity commonly is the water content "he" flow ceases from drainage tile. The emphasis is on drainage. Where soils drier than udic are prevalent, field capacity pertains to the water content after wetting by unsaturated flow to low tension. The latter, ordinarily, would yield somewhat lower water contents. (See section on Infiltration A221)

Laboratory estimates of field capacity are common. These are usually based on the water content against 0.1 or 1/3-bar (matrix potential) measured on the field-occurring fabric. A lower tension (0.06 bar) has bee" employed for sandy soil materials. If there are strongly contrasting particle-size changes, where the lower material is sandy, sandy-skeletal or fragmental, the laboratory estimate of field capacity for horizons with upper boundaries 1 m. or less above the contact should be increased. The increase would depend on the tension at which the laboratory measurement was made and the texture of the soil material. The assumed field capacity, of course, should not exceed the total porosity. A suggested guide follows for the relative percentage by which the laboratory retention should be increased:

	Sandy	Loamy	Clayey
1/10-bar	30	20	
1/3-bar	40	30	20

A1214 Usable Water

An sir-filled porosity above 10 percent seems necessary for a sufficiently rapid rate of diffusion of air (Weaseling and van Wijk, 1957). This suggests that the upper limit should not exceed the volumetric water proportion calculated Prom the relationship $(0.9 - \frac{Db}{Dp})$, "here Db is the bulk density of the moist whole-soil fabric, and Dp is the particle density.

Commonly the upper limit would be the water retained by field-occurring fabric against 0.1 or 1/3-bar matrix potential as measured in the laboratory. The minimum lower limit commonly would be 15-bar far cultivated crops. For non-cultivated plants adapted to arid conditions, the tension for the lower limit may be higher. The water retention against 100 bar is commonly about three-fourths of that against 15 bar. Therefore, except for clayey soil materials and unless a very much higher tension than 15-bar is assumed, the use of the 15-bar retention does not lead to a large over-estimation for the minimum lower limit.

There is also the question of the maximum lover limit. Soluble salts pose a problem. The 15-bar water retention or other limits defined by 8 laboratory measurement pertain to the matrix potential. Osmotic effects due to salt are not considered. The matrix potential for the lower limit should be reduced to compensate for the salt concentration. No guidelines, however, are suggested. Plants differ in their tolerance of salts and the same plant may range in tolerance dependent on the prior environment. Osmotic pressure may be calculated from the electrical conductivity of the water extracted from saturated soil material (USDA, 1954). The matrix potential for the lower limit may be taken as the difference between 15 bars and the calculated osmotic pressure for the Salt Concentration in the saturation extract. But in practice, such a calculation would provide only a very general guide.

A1215 Water Tables

The definitions of the several kinds of water tables are written in terms of operations that would be performed sequentially. The usual practice, however, is to install boreholes and then to make periodic observations. This leads to differences in the experimental procedure from those in the definitions. To determine whether a perched water table is present, two or more boreholes would be installed to different depths. One borehole would terminate above and others in or below the less pervious zone. Boreholes that pass into the less pervious zone would be cased, at least within and below the less pervious zone.

Uncased boreholes usually are lined to prevent caving. By definition, however, the lining would either be perforated or the zone immediately surrounding the outside of the lining would be sufficiently pervious that water may move downward and enter the borehole from the bottom.

Experience indicates that the pattern of water table depth over the year is quite repetitious from year to year. The number of years of measurement would depend on the consistency of the precipitation pattern, and whether the precipitation during the measurement period has been within the normal range. It also depends on whether observations o" a perched water table are of interest. Some perched water tables may be related to a given storm event, rather than reflecting the precipitation-evaporation balance of the several previous months. The occurrence of such perched water tables would tend to be more variable from year to year. Experience in areas of usually moist soils, where there is a pronounced winter excess of precipitation over evapotranspiration, indicate that two or three years' data suffice to give the overall yearly pattern. A single year is useful, particularly if the intent is to compare different Sails in a local association, rather than to characterize series concepts.

Frequency of observation depends on the purpose of the study. The maximum period between measurements should be one month, and measurements should be every 2 weeks during periods of rapid adjustments in water table levels, Weekly observations may be required to detect the presence of perched water tables.

Precipitation records for the site are preferable. Data may be applied, however, from nearby stations. The distance over which precipitation data may be extended depends on the particular local conditions. It also depends on the intent of the study. If perched water tables 81-e of interest that may result from severe local storms, then on-site precipitation observations are nearly essential. If the interest is in the yearly patter" of the water table (perched water table excluded) then precipitation records from 20 miles or even farther may be satisfactory. I" some instances the water table is "ot controlled by precipitation, but rather by a through-flowing stream, or by irrigation. Information, the", on the height of the stream and on irrigation practice would be required rather then precipitation data. Regardless of the source of the water, the same principle applies to the interpretation and extension of the water table data. The information on the source of the water for the years of measurement must be compared against long-term records in order to have a basis for judgment whether the water table data pertain to average conditions or to extreme conditions.

The vegetation and land use may affect the water table, through control over runoff and evapotranspiration. Vegetation and land use at the site should be similar to that for a significant portion of the soil or the soil phase.

Installation of boreholes may be accomplished in a "umber of ways. A procedure that has bee" successfully followed to study water tables in soils of the southeastern United States may be obtained from the committee chairman (R. B. Daniels, personal communication).

P. J. Zwerman (personal communication) points out the importance of diurnal fluctuation of water table height due to temperature changes. He writes: "I" a fairly dense soil of relatively low water holding volumes, the diurnal fluctuations that could be caused by temperature changes at the surface or by diurnal removal of water by vegetation, for example, the forest or a brush cover would be very substantial. ... these fluctuations in the field in the winter time under 8 system of continuous recording ranged in the order of about one foot."

A122 Field Glues for Water Status

I" this section a few suggestions are give" to assist in the placement of the moisture status in the correct class based on simple field observations or tests not involving actual measurements.

Ball test. Attempt to form a ball of soil in the hand by pressure. All textures finer tha" sandy will ball if high-moist or wetter. It becomes easier to ball for a give" water content as the silt increases relative to the sand and as the clay increases. Clayey soil materials may ball when low-moist. Guides have bee" puhlished by several state experiment stations to aid irrigators in assessing the moisture status from field-determined properties (Merriam, 1960). The ball test commonly is employed.

Water Films. At low tensions, films of water may be found on macroscopic structural surfaces that lend a shiny appearance to the surface. The soil material is above 0.1 bar if these films are present. Their presence suggests a tension of less than 20 millibars desorption.

Color. Work on this is in progress at the Lincoln Soil Survey Laboratory to determine whether soil material at 0.1 bar is darkened by further wetting, and whether the color at 15-bar retention is closer to wet or the air dry color. The relationship at the 15-bar water retention appears dependent on the clay percentage. If clayey, the color value at 15 bar is closer to the value when wet than to the value when dry. We are checking coarse loamy and sandy samples to see if the color is closer to the dry condition.

Consistence. Enough data are at hand from several laboratories to make feasible a rather complete investigation of the relationship between plastic limit and water status classes. The following is a very cursory examination of the question. Several published relationships between the lower plastic limit and clay are of the form y = a + bx, where a is 10 to 20 and b is 0.1 to 0.4. The regression of 15-bar retention on Clay would have a smaller a value and b would be about 0.4.

If after thorough disaggregation a durable ribbon 3 mm. diameter may be formed that does not crumble, the soil material is at or above the plastic limit. The plastic limit appreciably exceeds the 15-bar retention at low and moderate clay contents. At high clay content, the two values approach, but the 15-bar water remains below the plastic limit. The plastic limit is higher for silty than far loamy soil materials. Inferences about the water status of a sample that is at or above the plastic limit depend on the clay content, as follows:

very Fine	- Low-moist or wetter
Fine	- High-moist or wetter
Clayey	- Moist or wetter
Fine Loamy, Fine Silty	- High-moist or wetter
Coarse Loamy, Coarse Silty	- Wet

A123 Arithmetic Operations

Water may he expressed on a weight percentage or a volume proportion basis. The advantage of weight percentage expression is that it may be related more readily to other data, such as clay percentage, because the confounding factor of bulk density is avoided. For plant considerations, the volume proportion of water commonly is employed. This is obtained by multiplying the weight percentage datum by the bulk density, and dividing the quotient by 100. If coarse fragments are present, either the bulk density of the whole soil is employed and the water percentages, if measured on the < 2 mm., are adjusted to a whale-soil basis; or, the volume proportion is calculated using data for the < 2 mm. reduced proportional to the volume fraction of coarse fragments. The volume proportion is multiplied by the horizon thickness to give the amount of the water in the units of thickness of the horizon.

The amount of water in the various horizons may he added to give the total for a given thickness. In irrigation engineering, it is common to calculate a weighted average available or usable water over the depth of plant root withdrawal, usually 1 to 1-1/4 m. The zone of withdrawal is divided into four parts of equal thickness, which are weighted 4, 3, 2, and 1 in order of increasing depth (Shockley, 1955). Such a practice places major emphasis on the water retention properties of the plow layer.

A124 Water Content Determinations

The subject is well reviewed by Gardner (1965). A few additional comments may he useful. An instrument based on the reaction of calcium carbide with water to produce acetylene is widely used; it is marketed under the name "Speedy Moisture Tester." It is preferable to composite a sample and withdraw a subsample for the moisture determination rather than to use the volume samples provided with the instrument. (Need to discuss curves, caution for high water content material, doesn't measure gypsum water of hydration.) In some instances, it is not necessary to obtain the moisture percentage immediately, and an oven is not available. It is possible in these circumstances to obtain a" initial weight, allow the sample to air dry and weigh again. The air dry weight is then adjusted for the presumed water content, from check determinations or by assuming that the water content at sir dryness is 10 percent Of the estimated clay percentage.

AP1 Hydraulic Conductivity

AP11 Definition

Hydraulic conductivity is obtained from Darcy's Law. It is equal to the volume of discharge per unit time across a unit area under unit hydraulic potential. The term may be applied to either saturated or unsaturated flow. The numerical limits attached to the classes of permeability in the previous Soil Survey Manual were based on determinations of saturated flow in soil cores. The hydraulic gradient was nearly unity; hence, the values are expressable directly as saturated hydraulic conductivity.

The term, coefficient of permeability, as used in soil engineering, is equivalent to the hydraulic conductivity.

The term, permeability, may be used in the generic sense, that is, the property of a porous material which permits it to transmit water or air (Soil Science Society, 1965). In that sense, it may be employed to name classes. Permeability also pertains to a quantity obtained on analysis of data employing Darcy's Law. In the Latter sense, permeability has the units of area. It differs from hydraulic conductivity in that the viscosity and density of the liquid have bee" excluded. Permeability is conceived as completely a property of the porous medium.

Roth saturated and unsaturated hydraulic conductivity have importance in the description of soils. Rational design of a system to regulate the depth of groundwater requires information on the saturated hydraulic conductivity. On the other hand, downward movement of water in most soils usually is controlled not by the saturated hydraulic conductivity hut by the hydraulic conductivity under conditions of unsaturation, where the soil water is under some tension. Historically, the permeability in pedology has bee" numerically described in terms of the saturated hydraulic conductivity. Considerable data are available, both field and Laboratory on the saturated hydraulic conductivity. Class limits may be proposed that are grounded in experience. The same is not true for unsaturated hydraulic conductivity. Little data are available. It is uncertain where class limits should be placed. Moreover, there is the question of the tension to select or whether to select a particular tension at all.[c/] The hydraulic conductivity, particularly for coarse soil materials, is a very sensitive function of the tension in the range from 10 to 100 millibars. A tension near 30 millibars desorption might be a possibility. The tension is high enough that the hydraulic conductivity should be markedly reduced by coarse horizons, and yet the values range high enough to have significance in the time span relevant to the growth of annual plants.

To follow is a suggested set of classes for the saturated hydraulic conductivity of soi' horizons:

cm/day	
< 10	
	< 1
	1-10
10-100	
> 100	
	100-1000
	> 1000

c/ Rather than specifying a particular tension, the more feasible and likely direction of development would he to determine the moisture desorption curve and the dependence of the hydraulic conductivity on the volume proportion of water. Then it would be possible to compute the unsaturated hydraulic co"-ductivity for the conditions of interest. Such data are being obtained for a few soils by soil physicists (personal communication, J. Bouma).

Insoil engineering the separation between impervious and pervious soilsona three class scale of saturated hydraulic conductivity commonly is put at 0.01 cm/day, two magnitudes below the lowermost value of 1 cm/day used in the proposed set of limits. Soil engineers face questions where water movement over long periods of time, measured in years, may be pertinent. This is a different viewpoint from that governed by considerations of soil as a medium for plant growth, where the significant time span usually is measured in days or weeks.

The hydraulic conductivity of a soil, as contrasted to a horizon within the soil, presents further problems of definition. The depth or depth range to which the hydraulic conductivity should pertain has no completely satisfactory answer if the guidelines are to have wide application. In many soils, the zone beneath a root-limiting contact determines the hydraulic conductivity. In other instances, the surface horizon has the minimum hydraulic conductivity. Rut since the properties of the surface horizon which would control the hydraulic conductivity may change radically with land use and with stage in the cultivation cycle, it is questionable whether the surface horizon should determine the hydraulic conductivity of the soil. Regional differences in the common depth of placing tile raise complications. In wet soils of humid regions, the depth commonly is about 1 m. For irrigated soils that are commonly or usually dry, tile depth is at $1\frac{1}{2}$ to 2 m.

An important difficulty arises from the distinction between vertical and horizontal water movement. For purposes related to the capacity of the sail to transmit precipitation downward, the vertical hydraulic conductivity is the more important. If, however, the interest is in the installation of a drainage system, then the horizontal hydraulic conductivity becomes extremely important. In fact, the theories for the auger-hole methods of determining the hydraulic conductivity assume in part horizontal (or near horizontal) water movement. It has been common practice that the zone or horizon with minimum hydraulic conductivity determines the placement of the soil. This places complete emphasis on the vertical hydraulic conductivity. For unsaturated hydraulic conductivity, emphasis on the vertical would seem justified, But for saturated hydraulic conductivity, the horizontal hydraulic conductivity may be equally or more important.

Most determinations of hydraulic conductivity of soil cores Pertain to the vertical direction. Such determinations formed the basis for the hydraulic conductivity classes in the previous Soil Survey Manual. Also, soil morphological observations commonly are more reliable indicators of the vertical hydraulic conductivity than the horizontal, since the training of most soil scientists emphasizes the vertical rather than the horizontal morphological pattern. Therefore, if horizontal hydraulic conductivity is to receive emphasis, considerable adjustment is necessary in ho" morphological observations are interpreted for placement of soils into hydraulic conductivity classes.

With the foregoing as background, and recognizing the need to permit more than one level of detail, depending on the information available and the significance of hydraulic conductivity to the soil, the following is suggested:

Minimum--Give the minimum saturated hydraulic conductivity for 1/4 to 1 m.

Intermediate--Give the maximum and the minimum saturated hydraulic conductivity for 1/4 to 1 m. with the placement for the shallower of the two horizons listed first.

Maximum--The same as Intermediate for the 1/4 to 1 m., and for the 1 to 2 m. zones, if the latter are available. In addition, a minimum unsaturated hydraulic conductivity for the 0-1/4, 1/4-1, and 1-2 m. zones would be give"; the conditions to which this would pertain need to be developed.

For interpretive purposes, soils commonly are divided into zones, as for example in the engineering tables of published soil surveys. If there are differences in the saturated hydraulic conductivity of horizons within these zones, the maximum and the minimum hydraulic conductivity should be given.

A212 Measurement or Estimation

A2121 Methods

Field measurements of saturated hydraulic conductivity have been developed, both for above and below the water table (Boersma, 1965; Holmes et al, 1967). These measurements are dependent both on vertical and horizontal hydraulic conductivity, with the horizontal the more significant. Saturated hydraulic conductivity measurements on soil cores (Klute, 1965) are common. There are inherent limitations to such laboratory determinations. If the horizontal repeat distance between the voids that control the hydraulic conductivity is large, the cores may not be large enough to include a representative sample. Moreover, there is the limitation imposed by the height of the cores, which commonly is less than the thickness of soil for which the hydraulic conductivity is of interest. The controlling factor may be the continuity of the larger voids over the full depth of this soil zone, something that cannot be determined from relatively short cores. Despite these Limitations, soil cores frequently do yield values that are in accord with field measurements, and as indicated previously, measurements of soil cores have formed the basis for the classes of saturated hydraulic conductivity in the previous Soil Survey Manual.

A2122 Prediction

prediction of the hydraulic conductivity involves the integration of a large amount of information. A general procedure may not be written that would be applicable to even most soils. Exercise of much individual judgment is required. There are, however, some guidelines that may be formulated based on the macroscopic organization and s-matrix. First, however, a few general ideas about the movement of low tension water may be useful.

The movement of water in soils may be visualized as taking place both within the s-matrix and within structural voids between pedological features. The structural voids commonly are larger than the voids within the s-matrix. Hydraulic conductivity rises sharply with increasing diameter of the voids. To illustrate, the hydraulic conductivity for the idealized situation of flow between two parallel, planar plates would be proportional to the third power of the distance between the plates (Childs, 1969). And for circular voids, the hydraulic conductivity is proportional to the fourth power of the radius. Structural voids commonly are not present unless the soil material has sufficient fines for appreciable changes in volume on wetting and drying. Therefore, if structural voids are present, it is probable that the contribution to the saturated hydraulic conductivity by the s-matrix is Low relative to that determined by the structural voids. Consequently, the saturated hydraulic conductivity would be controlled by the size, continuity, and repeat distance of the structural voids and not by the composition and bulk density, which largely determine the hydraulic conductivity of the s-matrix.

The sensitive dependence of the saturated hydraulic conductivity on the radius of the void suggests that void size above about 0.1 mm. is not of itself a critical factor in determining the saturated hydraulic conductivity of soils within the range from 1 to 100 cm/day. Neither is the volume proportion of voids > 0.1 mm. of major significance taken alone. For the case of continuous parallel cracks 0.1 mm. in diameter a repeat distance that would equal one percent of the total volume leads to a hydraulic conductivity above LOO cm/day (Childs 1969, p. 182). The critical question, then, is not the size and abundance of macroscopic voids, but their continuity through the horizon or between certain depths, Therefore, in the field description of soils emphasis should be placed on the continuity of the > 0.1 mm. voids across the horizon and between the depth limits to which the saturated hydraulic conductivity pertains, for many soils from 1/4 to 1 m.

At very modest tensions the control over the hydraulic conductivity shifts from the structural voids to the s-matrix. Under idealized conditions, at 30 millibars circular voids above 0.1 mm. diameter would be emptied. The hydraulic conductivity at 30 cm. tension would therefore be reduced by voids > 0.1 mm.

Bulk Density--Some preliminary comments may be helpful.

In the use of bulk density (total porosity) to estimate hydraulic conductivity, a useful distinction may be made between swelling and non-swelling soil materials. (The separation would be at a COLE of about 0.04.) In the latter, the pore size distribution and total porosity do not change markedly with water content. Capillary forces are employed to explain the water characteristic curves. For such soil materials, a low bulk density when moist would suggest 8 relatively high proportion of macroscopic voids. Hence, the low bulk density would be suggestive of moderate or high saturated hydraulic conductivity.

For swelling soil materials, the situation is quite different. Water enters the soil in response to osmotic forces arising from the clay particles, and will continue to enter until either the osmotic forces are satisfied or there is an external constraint, either mechanical or a capillary tension. The pore-size distribution and the total porosity depend on the water content.

The bulk density when moist is not indicative of the content of macroscopic voids. A low bulk density may indicate a high water content, the result of a high potential for water sorption originating from the clays. Thus, a low moist bulk density for swelling materials indicates nothing about the hydraulic conductivity. The bulk density of the dry soil fabric is more indicative, particularly if this bulk density excludes the large cracks that form on drying (referred to as dry-clod bulk density). Such a bulk density is approximated by the determination on dry soil clods using a flexible plastic coating (Brasher et al, 1966). Low dry-clod bulk densities for swelling soil materials are suggestive of appreciable permanent macroscopic void space, and hence a higher hydraulic conductivity than would be expected if the dry-clod bulk density were relatively high.

The guide to follow 'pertains to saturated hydraulic conductivity. For unsaturated hydraulic conductivity, the relationship to bulk density is variable. A low bulk density may be the result of a high proportion of large voids which at low tension would be empty; these large voids would act to reduce the unsaturated hydraulic conductivity. A coarse material with a high bulk density may have fewer large voids and consequently a higher unsaturated conductivity than if the bulk density is low.

The bulk density of the fine-earth fabric is used. For sandy and loamy textures, the moist bulk density pertains; for clayey textures, the dry bulk density is the more indicative. For sandy textures, values below 1.5 g/cc suggest that the saturated hydraulic conductivity is not low; values of 1.8 or above suggest a lower than usual hydraulic conductivity. For loamy materials, the limits of 1.4 and 1.7 g/cc should be employed. For clayey materials, 8 dry-clod bulk density below 1.5 suggests that the hydraulic conductivity is not low.

The engineers (Taylor, 1948; p. 116) have employed a linear relationship between void ratio and the saturated hydraulic conductivity. Such a relationship may have applicability for soil materials with low extensibility; but not if the extensibility is high.

Cutans--Stress cutans > 2 cm. across are excellent evidence of low saturated hydraulic conductivity. Skeletans, if well expressed, suggest that the inter-ped voids transmit water readily, and the saturated hydraulic conductivity estimate should therefore be raised somewhat. Moderate and strongly expressed argillans on planar surfaces indicate that "hen moist the macrosurface does not seal completely shut; hence, the saturated hydraulic conductivity probably is not low. Argillans in voids within peds have little predictive value.

Particle-Size Distribution--Coarse materials tend to have large saturated hydraulic conductivities; Hazen's rule may be applied if the sands are uncoated (Taylor, 1948). If sufficiently coarse that the void space would be largely emptied at 30 millibar tension, the" the unsaturated hydraulic conductivity would be relatively low. Soil material coarser than 0.5 mm. has extremely low hydraulic conductivity at 30 millibar. The 0.25 to 0.5 mm. fraction would have intermediate values. Sand finer than 0.25 mm. would have high values.

Porosity--(This section has not been written. If we revise the discussion of pares in the morphology section of the Manual to make it as relevant as possible to hydraulic conductivity, then this section would be much simplified.)

Structure--The organization is in the form of a key. The classes are not hydraulic conductivity estimates. Rather, they indicate that the attribute or feature may be considered as indicative of a high, medium, or low saturated hydraulic conductivity, or has little predictive value. In passing, It should be noted that the scheme assumes that the moisture status is given.

Indeterminant: Apedal forms with planar surfaces (fragments) and moderate or strong grade "hen dry.

High: Granular and crumb if moderate or strong grade; single grain; pedal and apedal forms with planar surfaces (blocks, prisms, columns, fragments) if of strong grade when moist and smeller than very coarse.

Lo": Massive; pedal and apedal forms that are weak when dry; platy; very coarse pedal and apedal forms that are weak when moist.

Medium: Other.

A22 Other Terminology

A221 Infiltration

The topic is considered differently by hydrologists concerned with engineering design prediction than by sail physicists. Musgrave and Holtan (1964) present the former approach; Yong and Warkentin (1966) very ably present an introduction to the subject from the viewpoint of soil physics.

The hydrologist is primarily concerned with infiltration because of its relationship to runoff. The concern is usually with predicting the extreme conditions that would be the consequence of extended, heavy precipitation or at the season of the year when water additions exceed removal because removal by evapotranspiration is low. In contrast, soil physicists put more emphasis on the movement of water into initially dry soil, and the consequent water distribution with depth that results from this downward water movement. In engineering hydrology (following Musgrave and Holtan), infiltration is the flow of water through the soil surface. It is affected by the properties of the soil surface, the hydraulic conductivity of the soil horizons, and the amount and characteristics of the water storage capacity of the soil. After prolonged wetting, the controlling factor usually is the horizon or zone within the depth of wetting that has the lowest hydraulic conductivity. This hydraulic conductivity would be at low tension, but not saturation, since if the soil were truly saturated no water would enter. The infiltration capacity is the maximum rate at which water would enter the soil for the given conditions. Classes Of infiltration capacity have been proposed based on hydrograph analysis of rainfall and runoff data for soils that are under clean-tilled crops and have been thoroughly wetted. These infiltration rates range from < 2 cm/day for the lowest group to between 20 and 30 cm/day for the highest group.

The infiltration rate decreases curvilinearly with time as water is added to the soil. The above figures would pertain to the flat portion of the curve after sufficient time hnd elapsed that the rate of decrease was low.

The water distribution in soils as a consequence of infiltration may be predicted. A qualitative understanding of the process has importance both to soil management and in understanding soil genesis. The model assumes that macroscopic cracks do not extend to the soil surface and there is a supply of free water. The uppermost centimeter or so of soil becomes saturated under these conditions. Beneath this uppermost thin zone of saturation there is a second zone in which the water tension increases sharply with depth over a span of several centimeters to a tension where the water content is intermediate between field capacity and saturation. This is the transition zone. It merges into a thicker zone across which the tension increases only slowly with depth (if uniform materials, the water content would remain fairly consistent). This is the transmission zone. At the base of the transmission zone the tension again increases sharply with depth, and if the soil is dry beneath, there may be an extremely sharp increase in tension across what is referred to as the wetting front. With time, as the wetting front deepens, the gradient in tension across the transmission zone becomes smaller. Resultantly, the infiltration rate decreases with time. If the sail is dry, the gradient in tension across the transmission zone is greater than if the soil is initially moist; hence, the infiltration rate is higher. If the soil is moist, the wetting front advances faster. The same distribution holds qualitatively if water is added at a slower rate than the infiltration capacity. If water additions are stopped and evaporation is retarded, the water in the transmission zone and above will continue to move downward, but at a progressively slower rate, because the gradient in tension across the transmission zone becomes smaller with time. The water content at the end of one or two days would approach field capacity.

Except for the uppermost centimeter or so of soil, water is under tension; therefore macroscopic voids would not contribute to the infiltration capacity. If the large voids extended to the surface, the" they may transmit free water downward and the model as described is inappropriate. I" many clayey soils desiccation cracks da extend to the surface and in extreme instances may be the principal means of downward water movement during early stages of a storm.

Most soils are not uniform with depth and this leads to differences in water distribution from that predicted by the foregoing. It is because of these differences that the concepts of perched and virtual water tables (section All) have bee" introduced. If the upper part of the soil is more pervious than the lower, there will be a tendency for water to accumulate in the upper pervious zone after the wetting front enters the less pervious zone. The accumulation may be sufficient to produce a zone of saturation--and hence a perched water table. If, in contrast, the upper part of the soil is less pervious, the effect is the same as if water were supplied to the soil at a reduced rate. If the voids in a lower zone are predominantly so large that they are empty even at low tension, the" this zone is a barrier to water movement until the zone above is saturated. A virtual water table results.

A222 Percolation Rate

A "umber of tests that differ in details but are essentially similar have bee" proposed to determine the rate at which water moves from a borehole under constant head into the surrounding soil material (Public Health Service, 19). The principal purpose is to determine the design criteria for small-scale sewage disposal systems.

Usually the data cannot be analyzed using Darcy's law and should be distinguished from hydraulic conductivity. The tests stipulate a pre-wetting period. Nevertheless, the values obtained commonly are strongly influenced by the antecedent water status. Soils with high extensibility that are initially dry may have markedly higher percolation rates than if the determination is made after the soils have been wet for a long period of time. For soils with low extensibility, the effect of the antecedent water conditions on the percolation rate is variable. The percolation rate for a" initially wet soil is not necessarily lower than for a dry soil (Hill, 1966). The percolation rate is controlled by unsaturated hydraulic conductivity. If voids are large enough they may reduce the percolation rate. A very coarse stratum may lower rather than increase the percolation rate.

The relevant percolation rate commonly would be for a depth that extends downward from the lower half of the control section for most series to about $1\frac{1}{2}$ m. This limits the predictive value of the series concept as taken alone for percolation rates since the depth zone of interest need not necessarily be defined by the series.

A3 Water Regime

A31 Definition

A311 Soil Drainage Concept

Soil drainage in the previous Manual was used in two senses. In one sense, it referred to the balance between additions of water to the soil and the removal of water from the soil. In another sense, it referred to the frequency and duration when tbe soil was saturated or near saturation. The additions of water were determined by the climate and by the balance between runoff and run-on. The removal of water was determined by runoff and by the internal transmission properties of the soil. The water table regime was treated both as a consequence of the balance between addition and removal of water, and also independent thereof. Classes of runoff, permeability, and internal soil drainage were given. From these placements, the soils were to be placed in one of six drainage classes,

The comprehensive soil taxonomy system incorporates much of whet had been included in the soil drainage concept. The aquic moisture regime deals with the depth and duration of saturated conditions. The other moisture regimes (aridic, torric, ustic, xeric, udic, perudic) are descriptive of the balance between additions and removal of water at moisture contents below saturation. Soil drainage classes therefore have been dropped. The term, soil drainage, would be restricted to "... the process of the discharge of water from an area by streamflow and the removal of excess water from within the soil by downward internal flow; or, the means for effecting removal of water from soil, such as sloping topography, stream channels, open ditches, underground tile line, or pumped wells" (Soil Science Society, 1952).

A312 Taxonomic Placement

A3121 Technical Explanation

(No attempt has been made to write this section. It would depend on the policy on recapitulation in the Manual of material in the soil taxonomy volume.)

A3122 Nontechnical Terminology

The taxonomy terminology is not a suitable vehicle to convey the information about the soil moisture regime implied by the taxonomic placement to laymen. Below is a set of modifiers and their taxa equivalents. The intent is to provide guidelines for the preparation of statements descriptive of the soil water regime of the form:

> These are (non-wet, slightly wet, moderately wet, etc.) soils that because of the natural water addition-removal balance (rarely, seldomly, commonly, usually) lack water available to plants in most of the rooting zone of annual vegetation during the (growing season year, cool versus warm season).

Modifiers	Taxa
Continuously saturated	Peraquic taxa
Extremely wet, very vet	Aquic suborder
Moderately wet	Aeric subgroups of Aquic Suborders
Slightly wet	Aquic subgroups
Non-wet	Others
Rarely Dry	Perudic
Seldomly Dry	Udic
Commonly Dry	Ustic, Xeric
Usually Dry	Aridic, Torric

A313 Hydrologic Soil Groups

The Soil Conservation Service has developed a method for estimating the runoff from small watersheds from the amount of rainfall in a storm of 24-hour duration (Ogrosky and Mockus, 1964; Soil Conservation Service, 1964). The rate of rainfall is not considered and the method is not applied if the ground is frozen or for snowmelt. The objective is to provide guidance for the design of water retention structures and to estimate the frequency of flooding.

To understand the approach, imagine a linear plot of runoff versus storm rainfall. Now take the extremes. If no water entered the soil, there would be a 1:1 relationship. If the soil and vegetative cover taken together were highly pervious, there would first be a lag until the capacity of the soil to remove water was satisfied, at which time runoff would commence and rise with increasing rainfall. The curve, then, would be asymptotic to the rainfall axis for low amounts and bend upward to approach a 1:1 slope for large storm rainfall amounts. A family of such curves may be imagined, dependent on the infiltration capacity of the soil-cover combination for the particular antecedent moisture conditions.

A few runoff measurements for particular soil and vegetative cover combinations are available over a range in storm rainfall. Such data, however, are available only for a small fraction of the potential combinations of soil vegetative cover and antecedent moisture conditions. A scheme was therefore developed to estimate the runoff, using a family of curves relating runoff and rainfall. The shape of the curve is determined by the assumption about the potential infiltration of the soils. The potential infiltration is the inches of water that would enter a particular soil-cover complex in a 24-hour storm period. Each curve is assigned 8 number. These curve numbers range downward from 100, becoming progressively smaller as the potential infiltration rises. To select the proper curve relating runoff and rainfall, class placements are made for (1) the antecedent moisture condition based on the previous 5-day total rainfall, (2) the land "se or cover, (3) the treatment or farming practice, (4) the condition of the soil-cover complex as it would affect water infiltration, and (5) the hydrologic grouping of the soil. The proper curve (expressed as a number) to employ for the various combinations of the classes in these five categories is available in tables. To follow are descriptions of the four hydrologic groups (Soil Conservation Service, 1964):

"A. Soils having high infiltration rates even when thoroughly vetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.

"B. Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

"C. Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

"D. (High runoff potential). Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission."

Most of the soil series employed in the United States and territories have been placed in hydrologic groups; they appear in internal SCS documents. (Placements by taxa might be mentioned.) Some soils have an associated lend surface configuration that leads to ponding of water or to runoff over such short distances that it would not be significant to the design of water retention structures. Such considerations do not affect the hydrologic group placement. Adjustments are made for rocky phases of the soils. Installation of a drainage system apparently may change the placement. Therefore, although the placements are made primarily by soil series, adjustments are made for some phase criteria. Apparently, however, the slope of the soil is not explicitly considered.

Placement in the hydrologic soil group is based on concepts of the relative rate at which the soil would transmit water if bare and thoroughly vetted. Emphasis is on the movement of lox tension water after it has entered the soil, referred to as the transmission i-ate. The condition of the uppermost centimeter or so of the soil, as this may determine infiltration, is not considered in the placement.

Potential infiltration values for most soil-cover complexes range from 2 to 40 cm/day. The upper limit of 40 cm/day corresponds to the upper limit for the moderately slow permeability class (saturated hydraulic conductivity) as employed in current published soil surveys. I" actuality, the water would move downward by unsaturated flow. The relevant hydraulic conductivity could be markedly lower, particularly for soil materials having coarse and medium texture than the saturated hydraulic conductivity value. Part of the potential infiltration may arise from further wetting of the soil beyond the initial conditions. If the soil is initially at a water content corresponding to 0.1 bar water retention as measured in the laboratory (et the lower range of wet as defined in section All), the expected air-filled porosity would be from 5 to 20 percent. A meter of soil would have a water-holding capacity at a water content corresponding to the 0.1 bar retention of 5 to 20 cm.

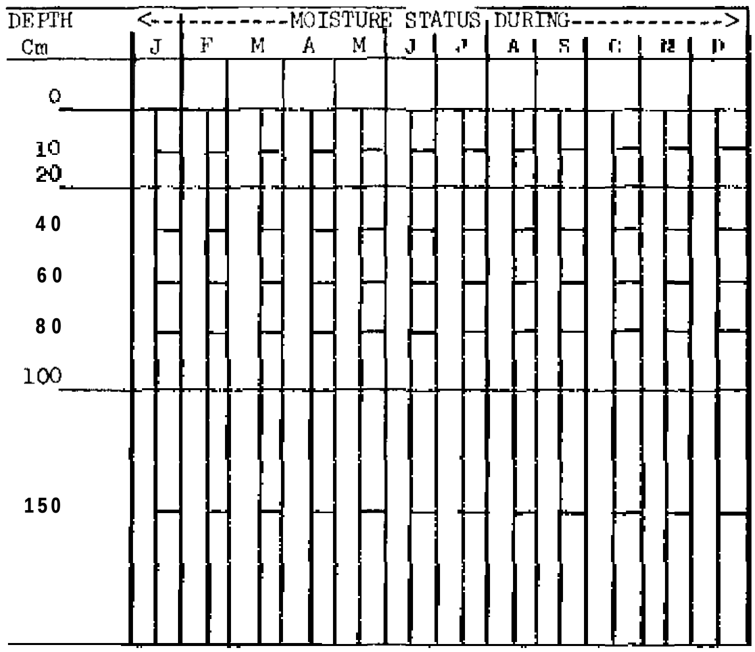
A314 Standard Description

The taxonomic placement of a soil implies many things about the water regime. There is a need, though, for a generally accepted format by which to record information about the water regime of a series, a soil, or a soil phase in order to have a record at a level of detail greater than would be implicit in the taxonomic placement of the series. The format should be adaptable to ADP. (In passing, it should be recognized that the standard description and the pedon data record for cyclical soil characteristics, such as temperature and moisture, need to be developed together.) A number of terms are defined in section All for the description of the water status. The water status would be described using some of these terms plus a few additional. The form would permit two(?) levels of detail for the depth limits, depending on how much is known about the soil. As a minimum, entries would be made for each month based on the condition over half of the time during the month in most years. An option to permit shorter time intervals for times of the year criticalto plant growth should be considered. The option of describing the extreme conditions in addition to or in place of the condition in most years would be permitted.

A partial list of terms to describe the depth-time cells would be:

Surface water
Frozen
Saturated
Ground water
wet
Moist
Dry

A visualization of a possible set of depth-time cells follows:



A32 Measurement or Estimation

A321 Field studies

A3211 Aquic Soils

(This section has not been written.. There should be an example or two fro" the literature. Some of the material now in section A1215 may belong here.)

A3212 Nonaquic Soils

(This section has not been written. It should include the selection of sites, depth limits to sample, useful laboratory data, methods of measurement. The intent should be to describe studies that may be done with simple equipment as an adjunct to a soil survey.)

A322 Calculations from Weather Data

It is premature to make suggestions about this section. There are several prior considerations, such as, (1) would the system being developed by Mr. Newhall for using weather data to predict the moisture regime be described in the Manual or otherwise determine what would be said about the subject; (2) to what extent should we explain or employ the Canadian approach, using the versatile soil water budget developed by Dr. Baier; and (3) what do we say about use of the Thornthwaite PE normals. I" regard to the last question, and as a good brief summary of the work in the field, to follow is a statement by Dr. Arkley:

"With regard to your request for a statement concerning the prediction of soil moisture from weather data, I suggest the following:

"Prediction of the soil moisture regime from climatic data can be made accurately only if a number of conditions can be "et. First the available water retention capacity of the soil must be known in terms of volumetric values such as ml./cm. or inches per foot. Second, a reasonably accurate estimate of potential evapotranspiration rates must be available. Unfortunately the empirical method of estimating PE proposed by Thornthwaite (1955) does not provide this, particularly in the western region of the U.S. where low humidity and clear, bright days prevail much of the year. FOP example, at 5 stations in California, PE calculated by Thornthwaite (1964)s only 62.2 percent of measured PE using grass covered lysimeters. However, PE can be estimated by other means such as from pan evaporation, net radiometer or atmometer measurements which are made at various experiment stations, etc. Third, an estimate of the amount of water lost by runoff during periods of intense rainfall must be available. Lastly, for other than continuous vegetation, an estimate of the percent of ground-cover present is needed.

"If these conditions can be met with reasonable accuracy, the water balance procedure developed by Thornthwaite and Mather (1955, 1957) using weekly or monthly values of PE and precipitation for each individual year or season, Should give a satisfactory estimate of the soil moisture regime; long-term averages, particularly of precipitation, should not be used.

"That is about the status of the art at the present time. The references mentioned are:

"1955, Thornthwaite, C. W. and Mather, J. R. 'The Water Balance.' Publications in Climatology, Lab. of Climatology 8(1):104 pp.

"1957, Thornthwaite, C. W. and Mather, J. R. Instructions and tables for computing potential evapotranspiration and the water balance. Publ. in Climatology 10(3):311 pp.

"1964, Thornthwaite Associates. Average climatic water balance data of the Continents, Fart VII United States. Publications in Climatology 17(3):615 pp."

A4 Water Chemistry and Characterization for Irrigation

There are a number of concepts that have been developed to characterize the instability of water for irrigation. These include total electrolyte concentration, SAR, calculated osmotic pressure, and residual sodium carbonate. Some of these concepts have application to sediment content of water, and hence pollution. There are other concepts that involve the interaction of irrigation water and the sail. These include leaching requirement and the valence dilution principle. The whole subject has been recently reviewed in ASA Monograph 11, Irrigation of Agricultural Lands. Should these topics be discussed? If so, where? Do we need a chapter in the revised Manual on soil and soil-water chemistry?

References

Boersma, L. 1965. Field measurement of hydraulic conductivity below a water table and Field measurement of hydraulic conductivity above a water table--in Methods of Soil Analysis, C. A. Black, ed. Agronomy Monograph No. 9. American Society of Agronomy, Madison, Wisc.

Brasher, B. R., D. P. Franzmeier, V. T. Valassis, and S. E. Davidson. 1966. Use of Saran resin to coat natural soil clods for bulk-density and water-retention measurements. Soil Sci. 101:108.

Childs, E. C. 1957. The physics of land drainage in Drainage of Agricultural Lands, 3. N. Luthin, ed. Agronomy Monograph No. 7. American Society of Agronomy, Madison, Wisc.

Childs, E. C. 1969. An introduction to the physical basis of soil water phenomena. J. Wiley, New York.

Donnan, W. W. 1957. Drainage Investigation Methods: II. Field investigations in Drainage of Agricultural Lands. J. N. Luthin, ed. Agronomy Monograph No. 9. American Society of Agronomy, Madison, Wisc.

Gardner, W. H. 1965. Water content in Methods of Soil Analysis, C. A. Black, ed. Agronomy Monograph No. 9. American Society of Agronomy, Madison, Wisc.

Hill, D. E. 1966. Percolation testing for septic tank drainage. Co"". Agr. Exp. Sta. Bull. 678.

Holmes, J. W., S. A. Taylor, and S. J. Richards. 1967. Measurement of soil water in Irrigation of Agricultural Lands, R. M. Hagan, ed. Agronomy Monograph No. 11. American Society of Agronomy, Madison, Wisc.

Klute, A. 1965. laboratory measurements of hydraulic conductivity of saturated soil in Agronomy Monograph NO. 9, C. A. Black, ed. America" Society of Agronomy, Madison, Wisc.

Merriam, J. L. 1960. Field method of approximating soil moisture for irrigation. Trans. Amer. Soc. Agr. Engr., Special Soil and Water Edition. "01. 3:31-32.

Musgrave, G. W. and H. N. Holtan. 1964. Infiltration in Handbook Of Applied Hydrology, V. T. Chow, ed. McGraw-Hill.

Ogrosky, H. O. and Vi Mockus. 1964. Hydrology of agricultural lands in Handbook of Applied Hydrology, V. T. Chow, ed. McGraw-Hill.

Peters, D. B. 1965. Water availability in Methods of Soil Analysis, C. A. Black, ed. Agronomy Monograph No. 9. American Society of Agronomy, Madison, Wisc.

Public Health service. 19 . Manual of septic tank practice. Public Health Service Pub. 526. (Use latest publication.)

Shockley, D. R. 1955. capacity of soil to hold moisture. Agr. Eng. 36:109-112.

Soil Conservation service. 1964. National Engineering Handbook, Section 4, Hydrology. Part 1 - Watershed Planning. U.S. Dept. Agr. (mimeo.)

Soil Science society. 1952. Report of the subcommittee on permeability and infiltration, Committee on Terminology. Soil Sci. Soc. Amer. Proc. 16:85-88.

Soil Science Society. 1965. Glossary of Soil Science terms. Soil Sci. Soc. Amer. Proc. 29:330-350.

Taylor, D. W. 1948. Fundamentals of soil mechanics. John Wiley, New York.

U.S. Dept. Agr. 1954. Diagnosis and improvement of saline and alkali soils. L. A. Richards, ed. Hdbk. 60.

Wesseling, J. and W. R. van Wijk. 1957. Soil physical conditions in relation to drain depth in Drainage of Agricultural Lands, J. N. Luthin, ed. Agronomy Monograph No. 7. American Society of Agronomy, Madison, Wisc.

Yong, R. N. and B. P. Warkentin. 1966. Introduction to soil behavior. MacMillan, New York.

Discussion

Coover: Accessible Water Concept should be applied to below 1 m.

Grossman: Not if the intent is an index number to apply widely.

Orvedal: How does one describe the water status of fragipans that have low water contents when saturated.

Grossman: The water-filled and saturated concepts would handle.

Bartelli, Flach: Important to discuss concept of unsaturated hydraulic conductivity in Manual, but not give classes.

Enderlin: Research engineers give saturated hydraulic conductivity in centimeters per second.

Grossman: Not a good unit for non-specialist. Too small.

Wilding: For septic tank filter fields the vertical hydraulic conductivity less important than the horizontal.

Johnson: Have to measure saturated hydraulic conductivity in the field.

Enderlin: Assume isotropic conditions in field measurement of saturated hydraulic conductivity.

Kellogg: Do not like term, "Water Regime."

Kellogg: The drainage concept involves concern with the need to describe the complexity of the actual field situation and the relationship to the landscape position of the soil. It also reflects in part the conditions under which the soil was developed. Previous drainage concept determined more by plant response; greater interest now in other soil uses.

Dideriksen: Should get away from water table and go to saturation. Use zones of saturation rather than water tables.

After the comments by Dr. Kellogg end by Mr. Dideriksen, the discussion of the section on the water regime became quite lively and cannot be recorded satisfactorily person by person. The reaction to the section on nontechnical terminology was affirmative. The reaction to the section on standard description (A314) was that it was a good approach, but how could it be implemented? Dr. Cline posed the question of organization of the material within the outline of the Manual as now under revision.

REPORT OF THE COMMITTEE ON SOIL FAMILY CRITERIA

The charge given to this committee in 1969 was to "receive, review, and evaluate recommendations from regional committees, task groups, snd others."

The committee reviewed the technical work-planning committee reports (1970) from the Northeast, North Central, Southern and Western regional conferences and considered other recommendations from the committee members.

The national committee considered that any attempt to develop major changes in soil family criteria at this stage in the development of Soil Taxonomy would be pointless and inappropriate. Rather, we should begin now to evaluate the usefulness of the family groupings already developed.

REGIONAL COMMITTEE REPORTS

1. Northeast - 1970 Committee on Soil Family Criteria

The regional committee requested clarification of the philosophy of the family category. The intent and purpose (objective) of family groupings are defined in Chapter 5 (the categories of the system) of the new Sail Taxonomy. In general terms it says that soils within subgroups having similar properties that respond to management and manipulation are placed in families. The criteria used for families and the ranges selected were chosen mainly because they were considered important in use and management. More detail on the philosophy of family separations would require a separate treatise and may well be a worthwhile undertaking.

The Northeast committee suggested the possibility of dropping reaction as a criterion for families of Aquepts. The suggestion was based on the observation that in the Northeast there are 32 families of Aquepts that have only one series each. This proposal received mixed reaction from the members of the national committee. One member favored dropping the reaction classes in Aquepts. Another pointed out that the national placements of soils into families show a significant number of multiseries families separated by reaction. For the present, reaction should probably be retained as a family differentia in Aquepts. However, we need to continue to look critically at families that contain only one series to see if they are needed.

The regional committee expressed interest in using sail consistence in separating soils at the family level. The soils that they are considering separating on this basis are till vs. outwash soils. The distinctions they want to make are quite important to the management of some of the soils because of the slow permeability of the compact tills. Some sandy till soils and sandy outwash soils are very difficult to keep apart, even at the series level.

The national committee recognizes the need to keep the till and outwash soils spare at some categorical level. However, they question the need to separate them at any level above the soil series. Further discussion is invited.

Considerable interest was expressed in ways of splitting large families. One member of the national committee commented on the use of "depth to rock" as a tool in splitting large families: "I would agree that 'depth to rock' would reduce the number of series in large families. However, it seems to be better Subgroup than Family criteria. I would prefer that less than 20 inches to rock be recognized at the Great Group level (i.e. Lithudalfs) and that 20 to 40" be recognized at the Subgroup level - Lithic Hapludalfs. At 40 to 60 inches, the rock would be series or phase criteria as it is now." The national committee did not favor such a change at this time. Perhaps such soils can be separated as phases of families.

2. North Central - 1970 Committee on Soil Morphology and Soil Family Criteria

No specific recommendations were made by the regional committee. A number of the problems discussed have been worked out by revising the definitions in the recent drafts of Soil Taxonomy.

3. Southern - 1970 Committee on Criteria far Family and Series

This committee limited their discussion to criteria for differentiating series within families and made no recommendations concerning family criteria. They were responding properly to their charge as stated.

4. Western - 1970 Committee on Soil Family Criteria

The committee recommended a shift in the upper limit for silt be shifted from 0.05 mm to 0.06 mm. Also, that all coarser particles be treated as sand and that the footnote regarding the treatment of very fine send be deleted.

The consensus of the national committee seems to be in favor of the recommendation. One member put this proviso o" his approval: "I would favor it if it were deemed adequate as (1) a family boundary, (2) useful to the engineers in place of the 0.075 mm measurement, and (3) adopted as part of our PSD scale.

This proposal had already bee" discussed at length by committee 3, so this was passed over without further comment or action.

OTHER RECOMMENDATIONS FROM NATIONAL COMMITTEE MEMBERS

One national committee member suggested that we explore the possibility of expanding the use of slope or land surface features at the family level. He said this would strengthen the useability of soil families for interpretive groupings. At present. slope is used only in aquic greet groups, particularly in Aquolls and Aquults. Other committee members favored restricting such usage as is now done in Soil Taxonomy and preferred the use of slope phases of families as needed to make meaningful interpretations.

RECOMMENDATIONS

1. The committee should be continued. Its charge should be to

   a. Receive, review, and evaluate recommendations from regional committees, task groups, and others.
   b. Evaluate soil families in terms of their usefulness in making meaningful interpretations

2. Regional committees should emphasize critical review of soil families co determine if they are designed properly to make them useful in interpretive work.

   a. Where and how have family groupings (or phases of families) bee" used?
   b. What problems, if any, have bee" encountered?
   c. Do they serve the needs intended?
   d. What families are not needed? Consider further the problem of single-series families

3. Continued attention should be give" to testing of the validity of series within families. Excessive numbers of series in each family suggests (1) weakness in the design of the family or (2) inadequate testing of validity of series.

Membership of Committee

J. E. Brown, Chairman*
R. I. Diderikson*
R. W. Eikleberry
K. W. Flach*
W. W. Fuchs
C. S. Holzhey
A. A. Klingebiel*
J. E. Witty, Secretary*

*Members present at Charleston, January 25-28.

Notes on Comments Made After the Report was Given

Kellogg: Purpose of families is to provide groups for making interpretations. Also, phases of families can be used.

Smith: Every category also serves as part of a key for grouping soils.

Johnson: Various categories are used as a basis for designing mapping units for different kinds of maps. If less precision is needed, the family categories can be used.

Klingebiel: The national committee understands the purpose for which the family was designed. Our report reflects the questions raised in the regional report.

Cline: Did the committee consider naming the families?

Brown: This was considered by the committee in 1969 but not repeated this year.

McClelland: Last year we approved use of the dominant series name as the common name of the family.

Bartelli: We are doing this now on the printouts.

smith: We have approved use of two common names for families which have wide geographic distribution if no single series within the family has the same distribution.

Simonson: Our studies show that there is an average of 2 series per family. There are about 4500 families and 9500 series.

Klingebiel: Family category really hasn't been given a good try yet. They could be useful in coordination of interpretations over a wide area.

Bartelli: Some states are testing families by comparing all series in the family before making interpretations for a series. This helps isolate "odd balls."

Fanning: The Chenango and Dekalb series are in the same family. They require very different interpretations.

Kellogg: Sounds like an error in placement.

Garland: Criteria of soil taxonomy put these soils together.

The report was accepted by the Conference.

Report of the Committee on Soil Interpretations at
the Higher Categories of the New Soil Classification System

The report of this committee to the 1969 conference included the following recommended activitie* for Regional Committees:

1. Refine and test some of the items (guides and criteria) set forth in the national report.

2. Develop small-scale maps and legend* of counties, states and regions using the new classification system with special emphasis on good interpretive legends.

3. Review the possibility of using more than one categorical level in preparing a legend for a state or regional small-scale map.

The following Regional Committee report* were reviewed by the National Committee.

Northeast Regional Committee Report

The report of the Northeast Committee was largely an endorsement of the 1969 report of the National Committee. The committee agreed that the main focus for the 1970 report should be on maps, legends, and interpretations at the state level; the 1968 report concentrated on work at the county level. Maps and interpretations for area, larger than states were not studied in depth. Committee discussion indicated that many of the general *oil maps in published soil surveys are not as useful as they should be. These maps are at a scale of about 1 inch equals 3 miles and this scale may be too small for some counties. Also, more attention needs to be given co the supporting materials for the general soil map.

The committee reversed the recommendation of the 1968 Northeast Conference by stating that phases of series is generally the preferred level for construction of map legends for county soil maps. The committee was about equally divided between preference for phase* of subgroups and phases of series at the categorical level for state maps. After discussion, t-he committee and the conference agreed that either level is acceptable, depending on the nature and complexity of the soil pattern. For any small-scale map, the categorical level should not be predetermined, but trial delineations, legends, and interpretations at different level* should be tested to arrive at the most effective kind of map and text.

The lay map users need not be concerned with the mechanics involved in the construction of a legend with mixed categorical level if the legend and the interpretation* are skillfully made. Construction of legends with two categories would be more difficult far *mix of series and suborder*, than for example, suborders and orders. Examples of parts of state maps which might well have legends at higher categories than the base level are for the Adirondack's area of New York and Cumberland Mountain area of West Virginia.

Many small-scale maps have been produced which lack sufficient information for non-*oil scientist use. At the same time, the inherent limitation* in small-scale maps must be clearly brought to the attention of the users.

Simple 1, 2, 3, 4 map symbols have definite advantages over connotative symbols. They are easier for the non-soil scientist to use; they permit updating the text to reflect changes in series or other taxa without necessitating revision of the map.

Recommendations by the Northeast Regional Committee

1. The Northeast conference endorses the recommendations of the 1969 National Conference regarding map scale, and the desirability of the use of standard map scales.

2. Legends for state maps should generally be at the level of either phases of associations of subgroups or phases of associations of families. For "low intensity" areas within states, a higher level may be appropriate.

3. The proposal for legends at more than one categorical level appears feasible and useful for some areas. Additional testing and examples are needed.

4. A statement as to the limitations in the use of all small-scale maps should be included in a prominent place, both in the interpretive tables or text and on the map. This statement should include the point that the map is not to be used for detailed or operational planning, and reference should be made as to the availability of detailed soil surveys.

The Northeast conference approved, without levying specific charges, the recommendation that the committee be continued.

The National Committee concurs in the four recommendations of the Northeast Regional Committee.

Southern Regional Committee Report

The report of the Southern Committee was, in general, an endorsement of the 1969 report of the National Committee. The members of the committee were asked by the chairman to respond to the charges levied by the National Committee.

The conclusions drawn by the chairman of the Southern Committee from the limited response by committee members are as follows:

1. The consensus was that the scales, the naming of mapping unit., and other guidelines as prepared by the National Committee are satisfactory.

2. Caution in using general soil maps for interpretations was strongly emphasized.

3. Meeting the decision making needs of a broad spectrum of specific users of soil maps and soil interpretations that will stand the test of time was the goal stressed.

4. In general, the committee favors using more than one categorical level in legends for state and regional small-scale maps. (The National Committee feels that this statement should have been qualified with a phrase something like "when necessary").

The chairman stated that information and experience is accumulating rapidly in the states and on a regional basis and that the Southern Region will be much more knowledgeable within a few years.

Example of map, legends, and interpretive tables from Mississippi, Tennessee, and Texas were attached to the report.

Recommendations of the Southern Regional Committee

1. The Regional committee be continued with the same or similar charges and that the subsequent chairman make a more concerted effort to find examples of small-scale maps end legends at the county, state, and regional levels.

2. The subsequent committee consider what interpretative decisions can be made from soil maps and legends of various scale and detail.

The National Committee agrees, in general, with the substance of the report of the Southern Regional Committee.

West Regional Committee Report

The chairman of the Western Committee appears to have adequately summarized the deliberations of this committee when he commented, "The discussion indicated that there is considerable disagreement on the usefulness of small-scale maps and the kinds of small-scale maps that are needed." During the discussion of the charges the following points were made, however:

> The Western committee stated that the map scale for county maps suggested by the National Committee appears to be reasonable. The components in the legend can be series (or groups of series) or phases of series (or groups of phases) depending on the purpose of the map. There is a need, however, for maps of larger scale for use at public meetings, on television and for display. (One member of the National Committee responded to this statement by commenting that there is also a need, by teachers of soil science, for wall-size maps of the United States and of the World and that someone should assume the responsibility far producing them and making them available.)

The committee pointed out that the small-scale map of the conterminous United States and the map of Alaska offer evidence that mapping units based on phases of subgroups are feasible at a scale of 1:1,000,000. At a scale of 1:500,000 the" mapping units based on phases of families of subgroups should be possible.

Recommendation of the West Regional Committee

> That one categorical level be maintained, if possible, on all maps. An extremely complicated patter" of soils in one part of a" area map, however, may require a shift to a higher level. A shift in categorical level might also be necessary where a great deal of detailed mapping has bee" done in part of a" area and no detailed mapping has bee" done in other parts.

The conference, without levying specific charges, recommended that the committee be continued.

The National Committee does not concur in the recommendation of the West Regional Committee that one categorical level be maintained on the legends of small-scale soil maps.

From the review of the reports of the regional committees, the following general conclusions can be draw":

1. The committees are in general agreement with the standard map scales suggested by the National Committee far county, state, regional and national soil maps. These are:

   (a) County maps: Map scales ranging from 1:125,000 to 1:250,000.

   (b) State maps: Map scales ranging from 1:500,000 for small states to 1:1,000,000 for moderate (average size) states.

   (c) Regional maps: For small regions use the same map scale as for States (b above) and for moderate and large sire regions use map scales of from 1:750,000 to 1:2,500,000.

   (d) National maps: Map scale of 1:1,500,000 to 1:7,500,000.

2. The committees are in general agreement that map units on small-scale county maps should be based o" associations of soil series or on associations of phases of series as appropriate.

3. The committees are in agreement that care should be exercised in the kinds of interpretations made at various levels of generalization.

4. Two of the committees either recommended or favored the use of legends at mixed categorical levels. One recommended that one categorical level be maintained if possible, and then gave two examples of situations where this may "at be possible.

5. Recommended that they be continued.

The regional committees are to be commended for a good job. The National Committee particularly liked the report of the West Regional Committee for the statement of items that they considered significant to small-scale maps and the use of such maps for interpretive purposes. These statements have bee" made a" attachment to this report. (Attachment #1).

Discussions and Recommendations by the National Committee

The regional committees have studied the making of interpretations for small-scale soil maps on which the map units are based either on association of soil series or on associations of phases of soil series. The National Committee feels that, although such interpretations should be the concern of every soil scientist, they are outside the present scope of the committee, except to the extent that these illustrate formats applicable to higher categories. Perhaps the committees, both national snd regional, should consider the relative efficiency of making interpretations at various levels in the classification system and to this extent should not restrict themselves to thinking only of the higher categories. If a real need exists for studying interpretations of associations of series perhaps the charge of this National Committee should he widened snd the name changed to Soil Interpretations of Small-Scale Maps.

The consensus of the committee members was, that in order to get widespread use of general soil maps, the general public must be able to understand the legends. In the *judgment* of the committee, the legend for the general soil map of Texas (Attachment #2), although it has several weak points, illustrates one way of combining "laymens" descriptions along with scientific soil names and represents a step in the right direction. One committee member, however, had mixed feelings as to the necessity for designing legends for general soil maps that the general public can understand. He stated that if our maps are to emphasize interpretation* the" he would agree that the legends should be prepared keeping the non-soil scientist in mind. If the map is going to be a taxonomic one, however, and interpretations are given in accompanying tables, then the kind of legend shouldn't really make that much difference to the "on-soil scientist since it will only serve as a key to the interpretive tables.

The committee members agreed that the map symbols on small-scale soil maps should be as uncomplicated as possible, either simple numbers (1, 2, 3, 4, etc.) or slightly connotative (Al, etc. for Alfisols; Dl, etc. for Aridisols; El, etc. for Entisols). Two of the members stated, however, that we need to recognize that there may he justifiable exceptions to this. I" the compilation of the 1:1,000,000 soil map of the United States, the legend must be an open one; the symbols, designed as they are, permit the addition of map units and still keep the legend organized.

Two formats of tables, one from Tennessee (Attachment #3) and one from Mississippi (Attachment #4), for handling interpretations of small-scale *oil map* are attached to this report. The one from Tennessee has the advantage of showing at a glance the distribution of limitation ratings for map units; but for people who do not know the soils, it has the disadvantage of not identifying the limitation rating with the soil name. This format uses a summary rating for stated uses of the map unit. The use of summary ratings had a mixed reaction from the committee because of the danger of this becoming the rating for each component in the spectrum of soils comprising an association. The consensus was that as long as the limitation of each of the component soils is given, the risk of users being misled by summary ratings is reduced and there would be no objection to include such ratings on interpretive tables. Sane planners find such ratings very appealing and, if they are to be used, it is better that "experts" give a summary rating to a map unit than laymen.

The subject of categoric levels to be used on the legends of wall-scale soil maps is one not easily reconciled in the minds of most soil scientists. The National Committee believes that the use of legends with either a single categoric level or several categoric levels can be justified. It is opposed to more mixing of categories than required to enhance the interpretive potential of the map.

The term "small-scale soil map" has bee" used in the Soil Survey over the years for any soil map (county, state, regional, and national) having a scale smaller than that used on the detailed maps which are a part of a published soil survey. In discussions the term is often loosely used; sometimes the magnitude of the number is improperly associated with the size of the scale (e.g. 1:1,000,000 is large scale and 1:126,720 is small scale). In one of the regional reports, the term "large scale small scale soil map" was used. The National Committee believes that with a" adequate definition for and subsequent correct use of the term "small-scale soil maps" our communication with others not accustomed to our broad use of the term would be improved. It makes no specific recommendation.

Recommended Activities for the Regional Committees

1. Continue to refine and test the guides and criteria set forth in the various regional and national reports.

2. Continue the development and evaluation of small-scale soil maps, legends, and interpretive tables of states and regions using the higher categories (family level and higher) of the soil classification system.

Should the National Committee be Continued?

There is no question about the continuing need for finding better ways to set forth interpretations for taxa in the higher categories, but there is a question about how much more a committee like this is likely to be able to do in the next two years, or even four. The committee has assembled a pretty good set of samples of legends and tables, and there is good agreement between the regional committees and the national committee. The decision to continue or to discontinue Committee 11, Soil Interpretations at the Higher Categories of the New Soil Classification System, is left to the discretion of this conference. Therefore, Mr. Chairman, although the regional committees recommended that they be continued, the National Committee recommends that it be discontinued.

The Conference approved the committee's report but voted that it should be continued with a reorientation of its activities.

Reorientation of Committee Activity

Discussion of the committee report by the conference called attention to the following points concerning general sail maps.

1. I" most instances there is "a relation between the general soil map in a Resource Conservation and Development Plan, River Basin study, Watershed study, etc. and the proposals and plans contained in such plans and studies.

2. The general sail map included in the kinds of plans and studies mentioned above usually da not agree with existing Regional and National general soil maps.

3. People really do not know ho" to use general soil maps. This is a public educational activity.

4. Soil scientists da not know how to use general soil maps to their full interpretive potential. This is an internal training problem.

5. Discussion of the general soil map in soil survey manuscripts needs re-examination. Should this discussion be in specific or in general terms?

The conference instructed the National Committee to wide" the scope of its activities to include the making of interpretations from small-scale general soil maps at various levels in the classification system, including that of the series. Suggested activities for the National Committee are contained in the "Notes on discussion concerning Committee 11 Report" appended to this report.

Recommended Activities for the Regional Committees

With reorientation of the National Committee, the four Regional Committees are requested to:

1. Continue the development and evaluation of small-scale soil maps, legends, and interpretive tables.

2. Concentrate their efforts on the general soil maps included in the published soil survey, Resource Conservation and Development plans, River Basin studies, etc.

3. Recommend ways of enhancing the interpretive potential of the general soil map included in the published soil survey, RC&D plans, etc.

These three recommendations supersede the recommendations previously given.

Committee Members

J. D. Rourke, Chairman
K. T. Ackerson
D. S. Fanning
A. C. Orvedal
G. D. Smith
K. K. Young

Notes on discussions concerning Committee 11 Report

Corrections in body of report

C. E. Kellogg (1) - References to "map scales" should be corrected to read "standard map scales". "se standard scales for maps. Fractional scales should appear on all maps.

M. G. Cline (2) - Bar scales are important also.

Continuance of Committee

A. C. Orvedal (3,14) - Inconsistency exists in recommending activities for Regional Committees and at the same time recommending discontinuing of the National Committee. Discontinuing Committee does not imply lack of importance of small scale maps but further effort along lines of current activity would result in reworking old material. Redirection of Committee effort would be possible.

J. D. Rourke (16) - Committee report includes idea of redirection as an alternative to discontinuing its activity.

C. E. Kellogg (15) - Agrees with idea of reorientation of Committee activity.

Suggested areas of activity for Committee

R. B. Grossman (4) - Some integration of watershed activities with mall scale maps would be possible.

L. J. Bartelli (5) - Resource conservation and development plans, river basin studies, Soil and Water Conservation District goals all rely on general soil maps, but there is nothing in plans of activities which relate proposals and plans to general soil maps.

C. E. Kellogg (6) - General soil maps are not made early enough.

L. J. Bartelli (7) - National Committee could provide guidance and instruction on use of general soil maps.

C. E. Kellogg (8) - Committee could prepare a guide far use of general soil maps.

V. G. Link (9) Conservation Needs Inventory could be tied to general soil maps.

C. E. Kellogg (12) - There are difficulties in using Conservation Needs Inventory data. Samples were not selected according to operating unite.

W. L. Anderson (17) - Resource Development Division welcomes the assistance of Soil Survey in improving the use of general soil maps in the Division.

General soil maps as reaching tools

O. C. Olson (10) - General soil maps are a valuable teaching tool. Detailed information is requested subsequent to study of general maps.

D. S. Fanning (11) - Need exists for wall-size maps for teaching and demonstration. These would assist in popularizing soil surveys.

R. I. Dideriksen (13) - In Indiana, general soil maps of counties are being updated. Consulting firms using present maps are using outdated information. A Planning Handbook has instructions for making overlays and special-purpose studies. Soils and genera, soil maps are used for explaining problems encountered.

ATTACHMENT #1

Statements from Report of Committee 7, West Regional Technical Work-Planning Conference for Soil Survey, Las Cruces, New Mexico, January 26-29, 1970.

- -

Before commenting on the charges we should first like to discuss some items that we feel are significant to small-scale maps and the use of such maps for interpretive purposes. We list then, not because they are original but because a few of them may bc overlooked and some have a bearing on our discussion of the charges.

Most map units on small-scale soil maps are associations. The associations may be of orders, suborders, great groups, subgroups, families, or series, or of phases of any of these categories. A few map units are undifferentiated groups or miscellaneous land types.

Interpretive statements can be made of individual map units or of components of map units, or both. Except in the case of map units consisting of very similar soils, many interpretive statements about individual components can be more specific than statements about map units. Although the precise location of the components is not shown on the map, in many cases the position in the landscape of each major component can be described. Thus a map user can, with some degree of accuracy, determine the kind of soil at most points within a map unit.

The higher the categorical level the fewer the assertions that can be made of any group, but a difference in categorical level does not mean there will be a difference in degree of specificity of all interpretive statements. Some statements can be as specific at the order level as at any lower level--for example, shrink-swell, hydrologic group, trafficability, and limitations for septic tank filter fields of Vertisols and Histosols.

I" most cases (perhaps all) levels of generalization to which meaningful interpretive statements apply are fewer than levels of categorical generalization within the soil classification system. For example, while the soil classification system has six categorical levels, probably no more than two interpretive levels are meaningful from the standpoint of limitations for septic tank filter fields, and no more than three from the standpoint of lime requirement.

Phases can be as useful on small-scale maps as on detailed maps, and the same principles apply in using that. Any class of any category may be subdivided into phases based on any characteristic significant to use or management. Phases may be based on selected criteria for classes at lower levels of the classification system; for example, texture or temperature phases can be used at the subgroup level, and lithic phases can be used at the great group level.

The importance of phases varies with the kind of interpretations being considered. For specific statements to be made about use of sails for irrigation, "arrow slope breaks, say of 2 percent, 5 percent, 10 percent, 15 percent, and 25 percent, may be necessary. For specific statements about use of soils for septic tank filter fields and sane other nonfarm uses, slope breaks of about 5 percent and 10 percent arc necessary (at least in areas where soils having a slope of less than 5 percent have a slight limitation and soils having a slope of 5 to 10 percent have a moderate limitation.) Shrink-swell, permeability, hydrologic group, load carrying capacity, lime requirement, and water-holding capacity do not vary by slope.

Small-scale maps can be made far a specific purpose (to meet the needs of a particular person or group) or for general purposes (to meet the needs of a variety of users).

Most small-scale maps will be made for the use of people other than soil scientists. This suggests that the legend should include a description of the soils in terms a layman can understand.

I" published soil surveys there generally is no need LO include a legend with derailed interpretations of components of map units 0" the small-scale map. I" reports containing small-scale maps but lacking detailed maps the small-scale map "ill likely be more detailed than otherwise.

The minimum-sized area that can be shown on maps of different scale is as follows:

1:7,500,000	900 square miles
1:1,000,000	15 square miles
1:500,000	4 square miles
1:250,000	1 square mile
1:125,000	.25 square mile

Once a small-scale map has been compiled it 18 a rather simple matter to rearrange the components Of each map unit in the legend LO reflect a particular interpretation or set of interpretations. A map unit based on an association of subgroups in most cases can also be a map unit based on an association of phases of subgroups by merely naming and defining the phases. Thus, more than one interpretive legend may be prepared for a given map. If the items to be interpreted do not require phasing of components for specific statements to be made, the legend will be shorter than if this is not the case. If a given map unit consists of several classes covering a wide range of, say, slope and slope differences are important for the purpose of the map, the legend describing components can be lengthy.

ATTACHMENT #2

GENERAL SOIL MAP - TEXAS
(In press - for release in 1970)

LEGEND

Explanation: To promote public understanding of the soil resources of Texas is the objective. Popular and scientific language are both used to facilitate communication among a broad spectrum Of users.

Main headings make a very general statement about the soils of a land resource area fallowed by a list of soil orders (i.e., Vertisols) predominant in the area. Orders are the highest or most general categories of scientific sail classification. Land resource areas are geographically-associated extensive units of land similar in a general way as LO soils, climate, natural vegetation and physiography. Each area is designated by a name commonly used within the state (see inset map).

Below each main heading a terse description and a list of Great Groups (i.e., Pelluderts) of soils are given for the one or more related soil associations which follow. The associations are the units delineated on the map. They have hyphenated names made up from names of two or three soil series of major extent within the delineation. Soils very similar as co kind, arrangement and thickness of natural layers or horizons are known as a soil series. A geographic name local to their occurrence is usually used in identifying them (i.e., Beaumont). Soil series in each association are in turn keyed to the appropriate Great Group, a category of scientific soil classification more definitive and at a level lower than the Order. Other soil series not named in an association occur in the area delineated and are included in the total acreage shown.

Symbols within delineations on the map relate to soil associations described and *classified* in the legend. Association symbols consist of consecutive numbers followed by a capital letter representing the Order of the first-named soil in the association, 1-V (Vertisols) through 73-E (Entisols). Since the symbol "A" is used for Alfisols, "D" is used for Aridisols. For the two types of Rockland, the symbol "T" is used.

GENERAL SOIL MAP - TEXAS
LEVEL SOILS OF THE COAST PRAIRIE AND MARSH
VERTISOLS, MOLLISOLS, ALFISOLS, ENTISOLS, INCEPTISOLS

Map Symbols for Soil Associations		Approx. Acreage
	Somewhat poorly and moderately well drained cracking clayey soils, and mostly poorly drained soils with loamy surface layers and cracking clayey subsoils:	
	Pelluderts[a], Albaqualfs[b], Argiaquolls[c], Pellusterts[d], Ochraqualfs[e], Argiustolls[b].*	
1-V	Lake Charles[a*]-Edna[b]-Bernard[c]	3,800,000
2-V	Victoria[d]-Orelia[e]-Clareville[6]	1,550,000
3-V	Beaumont[a]-Morey[c]-Crowley[b]	1,000,000
	Saline clayey and loamy soils of marshes and sandy soils of beaches:	
	Haplaquolls[a], Haplaquepts[b], Udipsamments[c]	
4-M	Harris[a]-Veston[b]-Galveston[c]	800,000
	Cracking clayey soils and friable loamy soils of the Brazos and Colorado River flood plains:	
	Hapludolls[a], Udifluvents[b], Haplustolls[c]	
5-M	Miller[c]-Norwood[b]-Pledger[a]	800,000
6-M	Moreland[a]-Pledger[a]-Norwood[b]	600,000
	Soils with loamy surface layers and mottled clayey or mottled to gray loamy subsoils:	
	Paleudalfs[a], Ochraqualfs[b]	
7-A	Katy[a]-Hockley[a]-Clodine[b]	1,450,000
	TOTAL	10,000,000

*The classification at the *Great Group* level of soil series in each soil association is indicated by the matching small letters.

ATTACHMENT #3
(Joe A. Elder, Tennessee)

County map of larger scale

LIMITATIONS OF SOIL AREAS FOR STATED USE

Soil Area	Main Soil Series	Degree of Limitation	Septic Tank Drainage Fields % of Area	Housing with Central sewage % of Area	Picnic Areas and Campsites % of Area	Streets and Roads % of Area	Agriculture % of Area
1. Red clay soils on rolling hills	Decatur	Slight	10	65	60	10	60
	Waynesboro	Moderate	20	10	20	70	15
	Lindside	Severe	70	25	20	30	25
	Minor series are Melvin and Talbott	Summary rating	Severe	Slight	Slight	Moderate	Slight

County To be put on face of map

1. Gravelly Hills and Ridges: Soils are 10 to 15 feet deep to limestone rock: they have good drainage and permeability except the narrow strips of first bottoms are often flooded and have high water tables during winter and spring; soils are yellow or red clays containing chert gravel; slopes range from 15 to 35 percent. The main roil problems are steep slopes, low fertility, and drainage in rhe small bottomlands.
Bodine-Baxter-Lobelville soil associations.
2.
3.

Exhibit #3 Onatef Mapse o f m a p

Cherokee Highlands: Steep, wooded ridges make up about three-fourths of the area and narrow rolling valleys between the ridges the rest. Soils on the ridges are loamy, stony and 10 to 25 inches deep to sandstone rock. Soils in the valley ate more than 50 inches to rock, permeable, and loamy, but are poor in fertility. Land suitable for cultivation is in small fields in the valleys. Numerous streams furnish clear, cool water to all parts of the area. Camping and picnicking sites are abundant, and good homesites are plentiful in the valleys. Highways require deep cuts in hard sandstone. The area has potential for recreation, forestry, and limited farming.

1. Typic Hapludults - Typic Dystrochrepts (Hartsells-Muskingum) Description of these units can be on back of
2. Typic Paleudults - Humic Hapludults (Jefferson-State) map, if they need to be described.
3.

ATTACHMENT #4
(W.B. Parker, Mississippi)

CLASSIFICATION AND SUITABILITY OF SOIL ASSOCIATIONS FOR DIFFERENT USES
NORTHEAST MISSISSIPPI RESOURCE CONSERVATION AND DEVELOPMENT PROJECT

Map Symbol	Soil Association and Percent of Project Area	Percent of Association 1/	Percent Slope	Parent Material	Drainage 2/
SQM	Savannah-Quitman-Mashulaville 4%				
	Savannah	30	o-7	Loamy coastal plain	Moderately well
	Quitman	25	O-3	Loamy coastal plain	Somewhat poorly
	Mashulaville	20	o-2		Poorly

Texture Subsoil	Depth 3/	Reaction 4/	Erosion Hazard	Residences: Community Services 5/	Residences: Individual Services 6/	Commercial 7/
Loam	20-24" to fragipan	Strongly acid	Slight	Good 8/	Fair	Good
Loam	18-22" to fragipan	Strongly acid	Slight	Good	Fair	Good
Low	16-20" to fragipan	Strongly acid	Slight	Fair	Poor	Fair

Agriculture: Cropland	Agriculture: Pasture	Agriculture: Woodland	Major Limitation
Good	Good	Good	Fragipan
Fair	Good	Good	Fragipan
Poor	Good	Good	Fragipan, high water table

1/ The remaining percentage consists of inclusions of other soils.
2/ Drainage refers to conditions of drainage that existed during the development of the soil.
3/ Depth refers to the depth that roots will easily penetrate to absorb water and nutrients.
4/ Reaction refers to the degree of acidity or alkalinity of a soil.
5/ Community services refers to such items as: Community water and sewage systems, streets, etc.
6/ Individual services refers mainly to suitability for septic tank absorption fields.
7/ Commercial refers mainly to suitability far shopping centers, parking lots and light industry.
8/ Underlined rating is the raring for the association.

REPORT OF COMMITTEE 12
SOIL SURVEY PROCEDURES

The recommendations of the 1969 National Committee, number 13; the 1970 Southern Regional Committee, number 9; and the Western Regional Committee, number 8 of the Technical Work-Planning Conference of the Cooperative Soil Survey were reviewed.

All but a few of the recommendations of these committees on Soil Survey Procedures have been placed in national soils memoranda. Implementation of these memoranda to accelerate the publication of soil surveys began early in 1970. This effort must be continued through fiscal year 1975 if we are to meet the schedule in the proposed five-year plan to accelerate the publication of soil surveys. By 1976 publication of soil surveys should be in balance with completion of field work.

If this balance is to be maintained it is essential that the soil survey field sheets and original manuscripts be of high quality and especially technically accurate. To assist in this effort the following guides have been or are being prepared.

1. Guide for Soil Map Compilation on Photobase Map Sheets - August 1970 - distributed September 28. 1970.

2. Guide for Authors of Published Soil Surveys - To be distributed - March 1971.

3. Annotated Guide for Authors of Published Soil Surveys - Draft - June 1971.

National plans include a study of the applicability of new developments in aerial photography (infrared and color photography). Included in these plans is a study of new remote sensing such as may be provided by Earth Resource Technical Satellites to determine the applicability to soil surveys. Also use of computers is planned or being studied for use in soil map compilation and preparation of soil survey manuscripts as well as for other phases of the soil survey program.

The national guides for preparing high quality soil survey field sheets, legends, and soil handbooks serve also as a guide for preparing the special soil reports with soil interpretations. In addition specific guidelines on the reproduction of and distribution of advanced copies of soil survey field sheets, soil surveys for town-and-country and community planning, reproduction of special "ports, and preparation of general soil maps are given in:

Soils Memorandum-68, July 29, 1968
" " -37, (Rev. 2) April 17, 1968
" " -39, (Rev. 1) April 28, 1967
" " -33. Revised August 14, 1961
" " -59, (Rev. 1) March 1, 1968

Special soil reports are being prepared for parts of soil survey areas during the mappine, operations and for entire soil survey areas immediately after field mapping is completed when there is an urgent need for special interpretive maps prior to publication. Also special soil reports are being prepared for parts of areas and entire areas for which soil surveys have been published.

Regardless of the status of the soil survey there is a continuing increase in the number of requests from planning groups for special soil reports of various kinds. Generally these reports consist of soil interpretive maps and/or tables and short descriptions of the soils. The great demand for these reports is indicative of the kinds of soil survey information that are being used effectively by planning groups. There also is an increase in the number of requests for on-site technical assistance requiring an examination of the soil and interpretations for various uses. These are activities requiring soil scientists' time in addition to the time spent preparing maps and texts for the published soil survey.

So that there will be more effective coordination of the different phases of the soil survey program and more effective use of the published soil survey, the committee recommends the following:

1. Descriptions of soils in published surveys for areas adjacent to a new survey area can be valuable to the survey party. They provide a record of series and phase concepts developed from many observations. Whether the soils of an adjacent area are like those of a new survey area, however, must be determined through study of the published information and through field observations in both the adjacent area and new survey area. If the same kinds of soils occur in an adjacent area with a published survey and in the new survey area, full advantage should be t&en of the published information when the identification and descriptive legends are being prepared. The published information can reduce greatly the amount of time required to develop the series and phase concepts independently. Such information can also serve as a guide in the making of observations and preparing descriptions of soils in the new survey area. The descriptions of soils for the descriptive legend should be prepared by first-hand observations in the survey area itself, Such observations are possible during the course of the survey, which will be the one opportunity for direct study of those soils over a span of several decades.

2. Each state conservationist with representatives of cooperating agencies should give consideration to re-evaluating the soil survey program in the state in an effort to determine how to reduce and keep to a minimum the large acreage of soil surveys (code 184), in unpublished soil survey areas, that is being canceled annually. In fiscal year 1970 this canceled acreage amounted to 19 percent of the total acreage reported as soil surveys. Most of the canceled acreage is in areas that have been mapped nonprogressively and are now being mapped on a progressive basis. Previous to mapping progressively the mapping has been dme primarily on a farm-by-farm basis and generally is more than ten years old, Consideration should be given to reporting to code 107 the acreage of this kind of rapping in areas not on the ten year completion schedule, without descriptive legends and without adequate supervision for quality control. The concensus of the Committee is that maximum value of a soil survey can be realized only if the field work is completed within five years and published within another two years. To do this and reduce the cancellation of large acreages of soil surveys annually will require a concentration of soil scientists in areas of high priority for soil surveys.

3. A one page soil interpretation sheet for each soil series (and phases) should be developed and sent to all states for use in coordinating soil interpretations between states. Each state originating a soil series description, for review by other states, would attach a copy of the completed soil interpretation sheet for that series. This procedure is now being followed in some regions but should be adopted nationally.

4. The Soil Conservation Service and cooperating agencies should develop a procedure for objectively testing the use of the published soil survey (maps and text) by people within the Service and outside the Service. Opinions, criticisms, and suggestions received from these people should help in developing better procedures for use of the published soil survey. Followup on this effort after meetings have been held to inform people how to use the published soil survey should be an assigned responsibility. Also good constructive criticism and suggestions should be obtained from both the SCS people and cooperators where the published soil survey is being used on a trial basis in resource conservation planning. Comments from all of these people who have used the published soil survey also may be helpful in determining how the contents nay be arranged for most effective use.

5. Because of the many uses being made of the soil survey, the Soil Conservation Service and cooperating agencies should develop suggestions and guides for overcoming soil limitations for all uses. This has been done for cropland, woodland, and range. The development of these recommendations could be a cooperative effort of the soil scientists, engineers, and representatives of other appropriate disciplines.

6. There is a continuing effort to improve the quality of the soil survey manuscripts submitted from the states and reduce the time required for reviewing these manuscripts in the Washington editorial unit. We suggest, therefore, that consideration again be given to implementing the following recommendation presented by Committee 13 "Soil Survey Procedures" of the 1969 National Technical Work-Planning Conference of the Cooperative Soil Survey. The state conservationist must set up state soil survey responsibility to provi& personal guidance for each author in preparing the first draft of a soil survey manuscript. This guidance should be provided by an editor and a soil scientist located in the state office. The work of each author would be checked at frequent regular intervals to insure that his work is being maintained at an acceptable level from start to finish. Where the state conservationist agrees with this procedure an editor should be employed and placed on the state staff to provide leadership in editing soil survey manuscripts and special soil reports. The time of this employee may be confined to one state where two or more manuscripts are prepared annually or the time of an editor may be distributed among two or more states where less than two manuscripts per state are prepared annually. This individual would work with soil scientists on the state staff responsible for soil survey manuscripts. The Washington office Would provide the training and technical guidance to these individuals. The editor on the state staff would be responsible for producing soil survey manuscripts that would not require any appreciable further review in the Washington editorial unit. Assistance in the preparation and review of manuscripts by the RTSC would be provided prior to the tim the manuscript is turned over to the state editor. The Washington editorial unit and the office of Chief, Manuscripts for Published Soil Surveys (Hyattsville) will be staffed to provide training and technical guidance to editors in the states, to proofread and make final checks on manuscripts prior to submission to GPO, and in addition to edit soil survey manuscripts from those states having insufficient work to justify employing an editor on the state staff.

7. Greater effort should be made to include members of the state staff, area conservationists. and district conservationists during the initial soil survey field review of an area. This group should determine the kinds of napping units required to met the needs for resource planning based on anticipated uses. Such a procedure will require more tine initially but should result in a better understanding of the objectives of the soil survey and more effective use of the published soil survey by these people and cooperators.

8. Electronic equipment and automatic data processing procedures should be evaluated for possible use to increase efficiency of soil survey procedures. The first components of an advanced mapping system for map manuscript compilation have been installed in the Hyattsville, Md. Cartographic Unit. Also developmental work under way at the South RTSC is providing useful experience (and ideas); and what is being learned there should be exploited fully in further studies. Possible use of ADP by state SCS offices should not be overlooked. At this stage greater emphasis is needed on studies--systems analyses--to determine not only feasibility but, more important, cost-effectiveness of alternative ways of preparing series descriptions, soil interpretations, and other parts of soil survey manuscripts, also soil c&relations and maintaining records of various kinds.

These suggested procedures when implemented should aid field soil survey operations, improve the quality of soil survey manuscripts, and increase the use of the published soil survey.

This committee suggests that a committee on Soil Survey Procedures be continued.

Suggested activities for future committees: (In addition to those suggested by the 1969 committee).

1. Continue to develop and evaluate procedures for obtaining greater and more effective use of the published soil survey. This includes presentation of the material in the publication and creating a desire to use it.

2. Continue to study and evaluate electronic equipment and automatic data processing procedures for possible use to increase the efficiency of soil s-v procedures.

- - - - - -

COMMITTEE MEMBERS

L. J. Bartelli	R. D. Hockensmith	Robert Shields
M. G. Cline	V. G. Link	Maurice Stout
L. E. Derr	R. F. Mitchel	Dirk van der Voet
J. V. Drew	H. I. Owens	Bruce Watson
J. A. Gockowski	S. A. L. Pilgrim	L. P. Wilding

Notes and suggestions during the discussion of Committee 12 Report - Soil Survey Procedures, January 28, 1971:

Bartelli: Objects to item 1 with respect to use of published material from a published soil survey in preparing a descriptive legend in a newly initiated soil survey in an adjoining county in its present form. Further stated that each soil survey is separate and soils must be studied and described anew as they are observed in that county. Suggested that Dr. Simonson prepare a statement that reflects a more complete approach to this objective.

van der Voet: As I understand the statement in the report, if you have two adjacent counties and it is known that soils and landforms are similar in both and one has been recently published and in the other a new soil survey is being started. then in the initial draft of the descriptive legend for the new soil survey area we make maximum use of the published descriptions where they are applicable. As the s-y progresses and new information becomes available, changes are made as needed.

Bartelli's motion carried by conference vote.

In addition to the Committee 12 Report Mr. Jerome A. Gockowski presented the following report:

Presentation at the National Technical Work-Planning Conference
of the Cooperative Soil Survey

Jerome A. Gockowski, Director
Cartographic Division

January 28, 1971

Photobase Sheets for Progressive Napping

The use of photobase sheets (atlas sheets) is recommended for progressive mapping where the field work will be completed within about a S-year period. Approximately 2 more years will be required before the survey is published which mans that the aerial photography would be approximately 7 years old. In many areas the land use change in 7 years would be negligible; in other areas there could be a tremendous amount of change and new photography would be required.

There are several advantages to utilizing photobase sheets for progressive mapping. These are:

1. Photography nay be obtained in the optimum season for photo interpretation. Most generally, this photography will be obtained when there is a lack of vegetative cover. In some states the soil scientist's field time has been reduced by 20-25 percent because of utilization of this photography.

2. Better quality mapping results through use of photobase sheets. Less matching is required. When a photobase sheet is used for mapping an average area of 700 square miles, 1:20,000 scale, approximately 450 lineal miles of matching are required. If individual field sheets are utilized with 4 sections mapped per sheet, these result in approximately 1,200 miles of matching, and if stereo pairs are used with two sections napped per photo, approximately 2,100 miles of matching are required. This matching represents considerable time, effort and cost.

3. Map manuscript compilation time would be reduced. If field mapping can be accomplished with publication symbols, the changes created by the correlation could be shown on an overlay and the overlay and the original could be sent directly to the map finisher. This would mean a cost of approximately $1,500 for map compilation by the state versus $6,000. which is estimated at the present tine for an average survev area. If the area is mapped on photobase sheets with the field mapping symbols, an overlay would likely be required which would show both delineations and publication symbols. Nonetheless, the total cost would be in the range of $3,000 to $4,000 versus $6,000 if the work has to be compiled from individual aerial photographs.

4. The quality of the photography would be appreciably better since these would be first generation prints of the original negatives.

5. Mapping at publication scale will allow the states to have better control of the survey making certain that cartographic detail is not excessive at publication scale.

There are also disadvantages. The atlas sheet measures about 11 inches by 17 inches and is more difficult to work with in the field. The photobase sheet is not the best training tool for new soil scientists since areas from 9 to 37 1/2 square miles are shown on each atlas sheet dependent upon the publication scale.

1 would like to spend a little tine discussing the development and the use of high-altitude photography. In fiscal year 1968, 4 areas with different flight characteristics were flown for the NCSS program. The result of studying these flights proved that this was a feasible means of obtaining photobase sheets in areas of la, relief. (300 feet within a 2 mile radius of any point.) In fiscal yew 1969, the states funded and received 8 areas. Nine were flown for the NCSS publication schedule. In fiscal year 1970 the states funded and contracted for 47 areas and 54 were flown for the publication schedule. In fiscal year 1971 to date, 17 jobs have been funded and are under contract for the states and 98 have been contracted for the publication schedule. We did not anticipate this degree of participation by the states; consequently, the Cartographic Division has problems in providing state funded photobase sheets to the field in a timely manner because of the accelerated NCSS workload. We are planning to have the field cartographic units assist the Hyattsville Cartographic Unit in preparing the photobase sheets for the field in a more timely manner.

Several factors are involved in the procurement of high-altitude aerial photography.

1. Publication scale must be stated in the soil survey work plan and adhered to in mapping. The flight specifications are designed to fit the publication scale and once the photography has been obtained, it is not possible to revise the publication scale for an area except at great additional cost.

2. The determination to obtain high-altitude photography should be made as early as possible in the fiscal year. Those areas to be flown for the states are added to a large contract for the NCSS publication program which is let early in the fiscal year. An example of the savings to be effected follows: A flying contract was let March 3, 1970, for 23 areas in 15 states. Three areas in Minnesota and Wisconsin were contracted at $4.31 per square mile. In the contract which was let September 22, 1970, for 103 areas, several areas in Minnesota and Wisconsin were bid at $1.75 per square mile.

3. You must indicate the flying season limits for the area dependent on your needs. If the contractor has a long lead time he will likely submit a low bid; however, if it is a close schedule, costs for flying this area will be high.

4. The contract procedure has been revised to allow a 25 percent increase in the bid items at the unit price in the contract, provided that close strictures are not placed on the contractor. If the timing is very close, a separate contract must be let for these areas. If the cost is estimated in excess of $2,500, a formal bid invitation must be issued and at least 6 weeks of lead time are required before the contracts are let. If the area can be contracted for less than $2,500, a minimum of 4 weeks lead time should be setup to allow time for the entire contracting procedure.

In conclusion, the use of photobase sheets will result in a cost reduction vehicle for progressive soil surveys and later for NCSS publication. These items must be considered:

1. Be certain of the publication scale.

2. Determine the flying season limits.

3. Submit an SCS-CART-19 to your cartographic unit with the above data, Funds are to be encumbered for the flying only. Your order should be submitted by July 31 of the fiscal year for the best unit cost.

4. Timeliness of service in getting the photobase sheets to you for progressive mapping will be improved.

Notes on discussion of Mr. Jerome A. Gockowski's Report:

McClelland: There appears to be a lack of communication with the states as to what high altitude maps will be available and when for map compilation by the states.

Gockowski: The states have been advised when these maps will be available. One hundred and twenty areas are due out in N 1971. We will be pushed to get these out on schedule. Some will be a little early, and some will be a little bit late. These maps should be in the states and compilation completed in no longer than 10 months.

Hockensmith: The photographs should be taken &ring the "leaf-off" period.

Gockowski: I have some comments to make regarding photobase sheets for progressive mapping.

Report of Committee 13 - Soil Surveys of Forested Lands

The purpose of this committee is to give emphasis to mapping procedures and interpretations in surveys of forest and rangelands. The committee has been specifically directed to review the lest regional forest soils reports. The Western and Southern regional reports dealt primarily with survey procedures and the North Central with interpretations and communications. "sing these reports as a starting point, we have attempted to identify some of the survey procedures and techniques that we believe warrant emphasis because of the more or less unique character of and/or conditions on the lands involved. Not that the soils per se are anything so unusual but because of the difficult access, observation, and profile examination problems that commonly pertain, designers of surveys on forest and rangelands face a different group of design problems than those faced by the designers of surveys on cultivated lends.

1 . Map scales. Rather than basing mep scale on complexity of the survey area or on kinds of information needed, we believe that the scale of mapping should very primarily with the expected use intensity of the survey information, which in turn is related to sire of the management units for which the information is needed. For general land use planning (extensive planning purposes) on large areas, relatively small map scales (upwards to 2 inches per mile) are usually adequate. regardless of complexity of the soil or land patterns. At this level of planning, one is concerned mainly with the gross characteristics of soils, vegetation, terrain, et al.--* matter of getting the big picture. He is concerned about soil potentials and hazards but largely from the standpoint of having potential problem areas roughly located and general information regarding the nature of the *oil-related problems to be expected. For project or intensive land use planning purposes, on the other hand, relatively large map scales are needed but again the map scale best suited depends on the intensity (scale) of planning end the typical size of the management units.

2. Survey intensity. Much stress has been placed on the matter of "viewing" soil mapping unit boundaries as an indicator of survey intensity. The intensity of the soil examinations within the delineated units hss received little or no emphasis in this regard. Happing unit boundaries on wild lands sod especially those on rugged end heavily forested areas, are tentatively placed through photo interpretation and verified in the field. Over the years, this approach has proved to be sound. practical, and efficient, provided, of course, that the soil scientist has developed the required photo interpretation *kills. Actually, many mapping unit boundaries on those lands can be determined more accurately or placed with more finesse through sharp photo interpretation than by visual examinations of the landscapes on the ground. On-the-ground examinations are necessary, of course, for identifying soils, for characterization purposes and so forth. but very few soil boundaries are traced out directly on forest and rangeland areas. Therefore. this committee believes that mapping intensity of forest end rangelands should not be judged an the basis that mapping unit boundaries are seen or not seen. 'This is not a meaningful criterion.

Intensity of field examinations and investigations within the mapping units is considerably more meaningful. This is the quality that makes one survey more reliable and informative than another survey of the same scale. This within-the-mapping-unit intensity feature, we believe. is one of the primary differences between reconnaissance and detailed surveys.

As for the intensity of the on-the-ground examinations, the Southern regional committee's report dealing with transects applies directly. Transects are a means by which both the mapping units and the taxonomic units can be reliably studied under difficult terrain conditions. Also. transects are "convincing" to most people. Transects thus furnish a basis for appraising intensity Of survey. Their presence or their lack could split the forest and range survey world rather neatly--reconnaissance would identify those surveys or those portions of surveys in which the composition and character of the map units are accomplished primarily by random (selected) site examinations. Detailed surveys would identify those surveys or portions of surveys in which the composition and character of the mapping units are determined primarily by sampling transects. The greater the degree of transect sampling, the greater would be the intensity of the survey, at least as far as characterization and mapping of the soil units are concerned.

The argument might be made that sampling transects are not necessary for certain kinds of areas. However, we recall that studies made of the composition of mapping units of surveys conducted without the benefit of transects have revealed some rather startling comparisons between what was reported to be present and what was actually found to be present upon checking with transects. To qualify for "detailed" survey on forest and rangeland, the use of transects should be a" essential procedure for obtaining and maintaining quality control of the mapping units. This is not to say that all or any surveys of forest and rangelands warrant the large investments in survey time that would be required; we are merely trying to recognize a basis for identifying quality.

3. Mapping units. We fully agree with the Western regional report wherein it is stated that "Surveys are most useful when natural landscape units are delineated and described in term* of series. phases of series, associations or complexes as may be pertinent." The important point here is that the mapping units be naturel segments of the landscape. The significance of this point should not be underestimated. It serves to correlate the unseen soil units with the observable features of relief and vegetation. To the foresters. range conservationists, landscape architects. and other potential users of the survey information. this is a vital step in gaining their understanding of what a soil survey is all about in the first place. It communicates.

4. Interpretations. We believe that the North Central regional committee on forest soils is doing an excellent job in identifying critical interpretive needs and formulating a positive program to coordinate research and the sail survey efforts. Forest site evaluations including studies to relate site index to volume yield and to quality of yield are badly needed in this region as well as all others. Getting yield data and many other performance and behavior qualities onto quantitative bases is long overdue. Such information is becoming essential in many resource analysis programs and the day is fast coming upon us when relative, qualitative ratings will be completely unacceptable to most users of survey information. Also badly needed as the North Central committee points out, is specific information about the effects of timber harvesting practices on forest soils. the soil effects resulting from various site preparation methods including scarification and prescribed burning, the soil effects resulting from drainage, fertilization, and insect and disease control practices. To be responsive to tomorrow's soil information needs, we must be continually improving the interpretive portion of these surveys today. For example, many sets of tree plot data from earlier years have not stood the test of time and change. The data were collected for trees in unmanaged stands. Host Plantings now are of superior stack tree seedlings and earlier findings are as outdated as agronomic crop yields of the last decade.

5. The work ahead. Because this committee is mainly concerned with "emphasis." we see a real need for recommending that this committee be continued. Its work should increase with the increased pace that appears to be in store for surveys on forest and rangelands. I" many areas of the country, the surveys are just getting started. There is and will be an extremely important and necessary Job in coordination between the various agencies involved in surveys. This committee could do much in this area alone. The committee recommends this report be accepted and that the committee be continued to evaluate the existing needs for improvement* in soil survey on rangelands and forested areas.

Committee members:

J. E. Brown
H. J. Byrd
J. R. Coover
c. M. Ellerbe
P. E. Lemmon
0. C. Olson, Chairman
s. A. L. Pilgrim
Dirk van der Voet

Notes on Discussion of the Report by the Conference

Kellogg: We are going to define the mapping units occurring in forested areas in term* of what we find there. If the taxonomic unit information is at the sub-group level. the" this will be used.

Olson: In addition, the mapping units should be natural segments of the landscape.

Kellogg: In designing the mapping units, are you thinking of interpretations and what we are going to do with them?

Olson: Yes. The degree of refinement must be in agreement with the way the information will generally be used.

Rourke: As you go about your mapping, have you considered setting up a small area to do detailed mapping? Such a" area could possibly be used as an example to determine the composition of ""its.

Olson: Some work has bee" done using this procedure. A" example is your exploratory surveys in Alaska.

Kellogg: What is the width of the transects you refer to?

Olson: We referred to line transects. The spacing of transects if pretty much related to the soil patterns, etc.

Orvedal: You have used the term "natural landscape unit." I have a problem with this term as it relate, to scale and size. If this term is to be meaningful, it should be related to scale, etc.

Olson: The sire of such mapping units depends on the scale of mapping which in turn is dependent on the survey objectives. For instance, information for project design purposes must be much more detailed than the information needed for short term planning purposes. Happing scale thus determines whether one delineates large segments of the landscape or simply facets of those larger landscapes.

Cline: Some of this matter of landscape is covered in parts of the revised manual. These new sections clarify some of this.

The term "reconnaissance" has also been defined in the revised manual. It allows photo interpretation for delineation but verification is still needed.

Klingebiel: There are many uses of general soil surveys other than range use. We need soil information for- all these-uses.

Olson: We do not have surveys that meet the needs of all users. We should identify the principal uses and design accordingly.

Kuhlman: We are involved in this. The minimum size of some of our units is 300 acres.

Kellogg: We have many detailed surveys that did not attempt to meet the needs for irrigation. If we had made all surveys of the western United States for possible irrigation use, the" we would have a very high cost input. We need to select areas of high intensity use.

Orvedal: Every map is a generalization of what is on the ground.

Olson: This is correct, and it applies to detailed soil surveys as well. This matter of detail is a relative thing.

Kellogg: The amount of delineation depends in part on the amount of contrast.

Cline: There is a stigma to the use of the term "reconnaissance." If we do "se terms for intensity of surveys. to what precision do we define the terms?

Klingebiel: I believe we need terms to define different kinds of surveys.

Olson: To a great extent, we are talking about one survey with scale varying according to the amount of detail that is wanted.

Kellogg: Would any of you be startled if the terms "detailed" and "reconnaissance" surveys were deleted from the Soil Taxonomy manual?

No conference participant objected to this proposal.

Cline: I *till feel that we may need terms for survey intensity.

Bartelli: We may want to set up some classes to serve as guidelines for this.

Cline: You can describe the mapping if you define the minimum size area that is delineated. The use of terms as high contrasting, etc., is also helpful.

Bartelli: If you follow the current definition of detailed soil surveys in the Soil Taxonomy manual, you will be okay.

Hockensmith: I am concerned about changes in the terms of kinds of surveys. We are currently working on a map showing the status of surveys in the United Staten. If the term "detailed" and "reconnaissance" were eliminated, there could be two categories of soil surveys on this map:

1. Surveys that meet the requirements of operational soil surveys.

2. Surveys that have useful information but do not meet the standards for operational planning.

Conference participants agreed with Mr. Hockensmith on these categories.

Olson: There would be need to define your term "operational planning." This is especially needed if this status nap is distributed widely. This is the key to the meaning of the separation.

Report of Committee 14
Environmental Soil Science

The quality of man's environment is of growing concern to professional workers and private citizens alike. As population grows, industrialization, urbanization, and the other complexities of our society grow. We face a new issue in "Balanced National Growth." The emphasis is on greater balance geographically for economic opportunity and improved use of our resources. It involves the expansion of industry into the Nation's 5,100 communities in the 2, 500 to 50, 000 population bracket at the cost of no further deterioration of both our urban and rural environment. This evolves into a most competitive demand for soil; but soil must be managed to keep source and use in harmony with demands. This is environmental soil science and the subject matter of this committee. Our objective is to collect and disseminate knowledge that will permit use of the soil as a sump for waste, as a waste-water treatment system, and at the same time permit a continued use of both soil and water. We hope to advise and assist in investigations and studies relating farming, forestry, and gardening to environmental quality. We need to keep abreast of new and changing technologies in soil management and their impact on the environment. We should understand the changing needs for soil. Our approach will be to summarize what is known and try to draw applications and interpretations from soil science for the various possibilities in enhancing the environment.

The following specific objectives were assigned to the Committee:

1. Assemble information on the behavior of nitrogen, phosphorous, defoliants, pesticides, and other chemicals in the soil.

2. Relate pollutant behavior with soil morphology and the soil taxonomic unit.

3. Promote and guide research in soil reaction with pollutants and wastes.

4. Develop guides that can be used to predict soil behavior in relation to degradation of pesticides and herbicides, breakdown of organic wastes, and filtering of polluted waters.

These objectives may imply that this committee restrict its activities to pollutants in soil. The committee recognizes the scope of this objective but hopes to encompass a much broader approach. It intends to study many other things including aesthetics and landscapes of soil. As more people demand more services -- places to live and shop and work and play -- soil scientists will need to play an increasing role in providing the amenities.

The first phase of this committee was to examine the literature and research activities to determine our present stage of development. This report reflects this study.

Research Activities

Many institutions are conducting research in some phase of environmental quality control that is related to soil. Table 1 summarizes the activities of ARS, USDA, in water quality research.

The Cooperative State Research Service, USDA, is encouraging coordinated research on environmental and waste disposal problems. Work groups or technical committees have been established in the experiment station regions. The work groups by regions are as follows:

1. Southern Region

   Effects of fertilizers and organic wastes applied to soils on environmental quality. Dr. J. F. Lutz, North Carolina, is chairman.

2. Northeast Region

   Disposal and utilization of dairy and poultry manures by land application. Dr. Norman Smith, Maine, is chairman.

3. Midwest Region

   Animal waste management with pollution control. Dr. A. C. Dale, Indiana, is chairman.

4. Western Region

   Disposal of wastes through soils and waters. Dr. Parker Pratt, U. C. R. California, is chairman.

Workers from state and federal research centers participate. The regional approach is not intended to set up regional research projects but rather organize individual center research in such a manner so that all contributions will fit together to solve a regional problem. Participation in these regional work groups is an effective way of learning what is going on and provides an opportunity to encourage needed research. Likewise, the presence of a taxonomist on these committees, hopefully, will result in a better and more relevant design of experiments. Currently, only the Western and Southern Committees include a soil taxonomist. These work groups have prepared literature reviews. Reviews from the south and midwestern groups are attached.

Table 1

WATER QUALITY RESEARCH IN THE SOIL AND WATER CONSERVATION RESEARCH DIVISION
AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE

BRANCH	POLLUTION SOURCE				
	Sediment - Other than Watershed	Pesticides	Nutrients	Animal Wastes	Other
Northeast		Beltsville, Md.	Beltsville, Md. Univ. Park, Pa. Burlington, Vt.	Univ. Park, Pa. (?) Danville, Vt.	Norfolk, Va. (Processing Plant Wastes)
Southern	Oxford, Miss.	Baton Rouge, La. Watkinsville, Ga.	Oxford, Miss. Florence, S. C. Baton Rouge, La. Tifton, Ga.	Watkinsville, Ga. Auburn, Ala. Rio Piedras, P. R.	Tifton (Watershed) Watkinsville, Ga. (Sewage)
Corn Belt	Columbia, Mo.	Coshocton, Ohio	Treynor, Iowa Morris, Minn.		
Northern Plains	Fort Collins, Col.	Fort Collins, Col.	Fort Collins, Col. Lincoln, Neb.	Fort Collins, Col. Lincoln, Neb.	
Southern Plains			Bushland, Tex. Durant, Okla.	Bushland, Tex.	
Southwest		Riverside, Cal.	Fresno, Calif. Brawley, Calif.	Riverside, Cal. (?)	Phoenix, Ariz. (Sewage Effluent)
Northwest			Twin Falls, Idaho		

What We Know

Many of the principles that govern the interrelationships between soil and its management for environmental quality are known. We know that the soil has abilities to provide suitable sites for living and working. It can immobilize, transform, and/or transmit components of various waste materials placed in or upon it. It is also self-renewing or self-cleaning. Furthermore, it can remove pollutants from contaminated waters. A better understanding of the soil properties that govern the behavior of pollutants in soil will enable more effective predictions of soil behavior. Some of the important relations are:

1. Mineralogical character.

a. Work on geological specimen clays has shown that the clay minerals dictate many of the behavior patterns. The 2:1 type (three layers) is much more active than the 1:1 type (two layers). The less active kaolinitic type has lower cation exchange capacity, absorbs little if any water, and has low adsorptive capacity for inorganic and organic ions. The more active montmorillonitic type clays have much higher specific surface and absorb much more water with great changes in volume. Clay and organic matter are important in removing phosphates. Clays with low cation exchange capacities seem, in general, to retain more sulfates. Clays with high heat of wetting tend to be more effective in cooling waters.

b. Recent work has shown that soil clays do not behave as the geological specimens do. For example, kaolinitic soil clays are much finer and more active than those in geologic deposits. Soil mineralogists need to relate mineralogical character and behavior to soil morphology.

2. Biological properties. Soil contains variable populations of bacteria, actinomycetes, fungi, algae, protozoa, earthworms, and rodents. The microorganisms are most dynamic in that they are part of the biological interactions that result in the destruction of organic matter. The rate of decomposition of organic matter varies among kinds of soil. The magnitude of carbon mineralization is directly related to the organic carbon content of the soil. The greatest rate of CO_2 evolution occurs near the surface of the profile where the highest concentration of organic matter occurs. Soil reaction is also critical. Each bacterium, fungus, and actinomycete has an optimum pH for growth and a range outside of which no cell proliferation takes place. Carbon mineralization is most rapid in neutral to slightly alkaline soils. Moisture level likewise affects soil respiration; the soil must contain sufficient water for maximum microbiological action. Nitrogen levels in the soil also control the rate

of decomposition. A low nitrogen content or a wide C:N ratio is associated with a slow decay.

Nitrogen also is susceptible to microbial transformation. In the nitrogen cycle, nitrogenous compounds are decomposed in three steps -- aminization of proteins, ammonification, and nitrification. Soil properties such as moisture, pH, aeration, temperature, and the inorganic nutrient supply will govern the rate of mineralization. The optimum moisture level for ammonification generally falls between 50 and 75 percent of the water-holding capacity of the soil.

Denitrification, the process that results in the liberation of molecular nitrogen, requires a good supply of readily oxidizable organic cornpounds, high nitrate levels, and poor drainage. Saturated soils are effective in breaking down nitrate nitrogen. The production of elemental nitrogen is greater in neutral than in acid soils.

The major factors governing microbial destruction of herbicides in soil are temperature, moisture, pH, soil depth, and organic matter level. Thus, a rise in temperature, or the liming of an acid soil tends to hasten the breakclown. Also, the rate of decomposition is more rapid in the surface horizons than at lower depths. Likewise, it is more rapid in neutral than in acid conditions. Soils high in organic matter are much more effective in breaking down these compounds. All breakdown has not been varified as being microbiological. Chemical and photochemical reactions also have contributed to the breakdown.

3. Saturated and unsaturated hydraulic conductivities. Soil morphologists, who have studied this behavior pattern in the field, do know that it is difficult to measure. It changes seasonally. Yet, the soil scientist can estimate water movement in a soil with a very high degree of accuracy. Some of the behavior patterns can be identified with soils as follows:

a. Soils with fragipans. Water enters the surface and moves through the rather structureless horizon above the pan as a wetting front. When it reaches the pan zone, where a change in hydraulic conductivity occurs, water piles up and eventually flows along the gray polygonal cracks of the fragipan.

b. Soils with strongly structured B horizons. Water enters and moves through the surface layers as a wetting front, but moves mainly along the ped faces in the subsoil.

c. Soils with weak or no horizonation that do not crack. Water moves through the soil as a wetting front under an even tension. Layers of different textures, as in a stratified soil of the flood plain, will intercept this flow. Contact is made with most soil particles.

d. Cracking soils. These soils when saturated, are very slowly permeable, but when dry act as very permeable soils. Water flows freely along the cracks. These cracks are not permanent and seal after saturation.

4. Soil temperature. Temperature has a profound influence upon the rate and extent of organic matter decomposition. Some humus decomposition can proceed at temperatures down to freezing but most bacterial activity stops at 5° C. Little oxidation occurs at 7° C. At 37° C. the oxidation is extensive. Denitrification - process of liberating molecular nitrogen is most active at 25° to 30° C. The optimum temperature range for nitrification lies between 30° and 35° C. Ammonification is most active between 40° and 60° C. Family soil temperature classes characterize the biological activity. Soils in hyperthermic families, where biological activity is for 12 months and thermic families where action is almost as continuously, are much more effective than frigid or pergelic families. Activity is restricted to summer months and at shallow soil depths in these colder soils.

5. Soil moisture. Soil moisture regimes are defined in terms of the ground-water level and in terms of water held at tensions less than 15-bars. The aquic moisture regime implies a reducing regime virtually free of dissolved oxygen due to saturation by ground water, Organic matter decomposition is principally anaerobic and is much slower in an environment with inadequate oxygen supply. Breakdown of carbonaceous material is incomplete. Ammonification is carried on by both aerobes and anaerobes and is not eliminated by waterlogging. Denitrification is appreciable in soils with aquic moisture regimes. In well-drained soils, denitrification is related to the moisture content. No losses in nitrogen occur at moisture levels below 60 percent of the water-holding capacity. During the rainy season when well-drained soils are almost waterlogged, denitrification is active.

6. Filtering properties. The soil's capacity to filter bacteria and virus out of discharge effluent varies with particle size of the medium and length of travel. Length of travel is small when particle size is fine grained and increases as particle size increases. The length of travel may range from one to two inches to 50 feet or more. Virus tend to be removed in the same manner as bacteria. Studies with infiltration ponds at Lodi, California, on Hanford soils show that the coliform count declined to less than the U. S. Public Health minimum standard of one organism per 100 ml. by the seven-foot level. Also, the number of

coliforms penetrating one foot or more is essentially independent of the intensity of pollution of the waste water, Caldwell 1/ attributes such a diminishing of coli to "soil defense" -- a mechanism by which soil bacteria, oxygenation, and nitrification kill most harmful bacteria before they travel an appreciable distance.

What We Need To Know

We need some basic bench-mark studies on the physical, chemical, and biological properties of soils as related to waste disposal. Studies should be designed to relate the soil's behavior pattern with key soil characteristics. This will enable us to extend the results to other soils and predict their behavior. Specifically, we need to know the following:

1. The capacity of a soil to degrade heavy applications of organic waste. Soil microorganisms decompose organic waste to carbon dioxide, water, and free nitrogen under aerobic conditions. Nitrogen is converted from nitrates under anaerobic conditions. In addition, herbicides, insecticides, and fungicides are destroyed by soil microbes.

2. The most effective cover crop, Growing plants also remove nitrogen and other elements. Water soluble nitrates applied to well-drained soils during periods of dormant plants are much more susceptible to leaching than if applied during periods of luxuriant plant growth.

3. The dynamics of liquid movement through the landscape. Infiltration and permeability rates govern the soil suitability for use as a filter field. We need to be able to integrate this knowledge with what goes on in the larger cycle of soil, water, air, and rock.

4. The fixing or exchange capacity of a soil to accumulate chemicals applied in farming. Inorganic salts, once in the soil, do accumulate. Inorganic compounds, such as the phosphate ion, and most pesticides are held tightly by the exchange complex of the clay and humus. Negatively charged ions, such as nitrates and sulfates, also are held by many soils.

5. We need to develop techniques for pinpointing and monitoring source of sediments in the watershed. Soil is a source of sediment. Some sediment may be a high carrier of pollutants, others may not be. Procedures for assessing the level of pollutants in sediment also are needed.

1/ Caldwell, E. L. 1938. Studies of subsoil pollution in relation to possible contamination of ground water from human excretia deposited in experimental latrines. Jour. Infectuous Disease. Vol. 62, pp. 271-292.

6. We need to assemble enough factual information to help local people prepare the design and performance standards that will be needed to control and legislate adequate quality in the environment.

Committee Recommendations

This committee recommends that similar committees (Environmental Soil Science) be established at the Regional Soil Survey Workshops. Membership should be expanded to include other state and federal agencies involved in related work. These committees may be charged with the following:

1. Each regional committee prepare a literature review on information as to how degradation rates of pesticides and herbicides may be affected by the various soil properties that are used to define soils in the cooperative soil survey.

2. Each regional committee survey the research work involving environmental quality at each institution within the region and summarize those activities that are related to pedology.

3. Each regional committee is encouraged to participate with respective CSRS regional work groups. The soil survey regional work-planning reports should include those studies and findings that are useful in soil survey work.

4. Regional committees are encouraged to isolate soil properties that influence soil behavior in organic waste breakdown, Preliminary guide lines for rating soil behavior may be attempted.

5. Regional committees are encouraged to survey research in hydrology and integrate this work with soil survey activities.

The committee recognizes the immense value of soil survey in preventing and solving waste disposal problems, water pollution problems, and town and country growth problems. The expertise which has been assembled in soil survey will contribute, but we must recognize that most of these problems are interdisciplinary, and several specialties must be involved. Probably the area in which we are most lacking is in soil microbiology and the hydrology of soil water. We can estimate hydraulic conductivity rates, or infiltration rates for a soil, but we lack a good understanding of how water moves through and off a landscape. It behooves us to increase our knowledge; for as we advise on the disposal of wastes or in planning a community, we must be both vigorous and cautious. We must be vigorous in improving the environment but still cautious enough to be sure that we have the facts needed for doing the job.

This committee recommends that a committee on Environmental Soil Science be continued.

Committee members:

*Lindo J. Bartelli, Chairman, SCS, P. 0. Box 11222. Fort Worth, Texas 76110
C. R. Berdanier, Jr., Soil Survey Laboratory, Beltsville, Md.
J. B. Fehrenbacher, Agronomy Department, University of Illinois, Urbana, Illinois 61801
T. E. Fenton, Agronomy Department, Iowa State University, Ames, Iowa 50010
*K. W. Flach, Soil Survey Laboratory, SCS, P. 0. Box 672, Riverside, California 94802
*R. B. Grossman, Soil Survey Laboratory, SCS, Lincoln, Nebraska
George S. Holmgren, SCS, Lincoln, Nebraska
*Victor J. Kilmer, TVA, Department of Soils, Muscle Shoals, Alabama 35660
*Gerald W. Olson, Soil Survey Interpretations, Department of Agriculture, Cornell University, Ithaca, New York 14850
Oliver Rice, USDA, SCS, Hyattsville, Maryland
*R. H. Rust, Department of Soil Science, University of Minnesota, St. Paul, Minnesota 55101
*Guy D. Smith, Soil Survey Investigations, SCS, Washington, D. C.
*L. P. Wilding, Agronomy Department, Ohio State University, Columbus, Ohio 43210

“Members present at workshop.

COMMENTS:

Dr. Kellogg suggested that we should not overlook the role of other animals. He added that rodents, worms, and nematodes can play an important role.

Review of Literature

During the past several years there has been tremendous concern about the pollution of our environment, including the soil, the water, and the atmosphere. This has been given much publicity through the various news media and there are those who paint an extremely dim view of the future (8). There are many sources of pollutants in soil and water (5, 6, 12). Soils may become contaminated by the accumulation of excessive salts, by the unwise use of certain agricultural chemicals, by deposition of undesirable sediments (eroded from other places), by accumulation of materials from automobile exhausts, and otherwise.

Waters may be contaminated by sediment resulting from erosion, by salts leached from saline soils, by industrial, municipal, and agricultural wastes, by animal residues, by agricultural chemicals including certain fertilizer elements, and otherwise.

Because this proposed regional project is limited to a study of the extent to which certain fertilizers and organic wastes might pollute soil and water the literature review will be limited to the effects of nitrogen, phosphorus, and certain organic wastes on soil and water contamination.

Eutrophication caused by excessive amounts of nitrogen and phosphorus in the water is one of the more common, current complaints. The nitrogen and phosphorus in water may come from many sources including municipal sewage, industrial waste, soil erosion and leaching, and other agricultural wastes including animal manures and other animal residues.

During the past 25 years fertilizer usage in the Southeast has increased 50% and in the United States as a whole approximately 200%. Beaton and Tisdale (3) have calculated the potential usage in the United States. Their figures show a potential increase of 118% in the Southeast and 111% in the United States compared to the 1968 consumption. These figures ere not predicted amounts but with the increase and demand for food it is likely that they will be met or exceeded in the not to distant future. If so, it will become increasingly important to determine to what extent, if any, commercially applied fertilizers are lost to waters. Figures. published by the National Resources Board in 1934 (20) shdw that 8,500,000 tons of nitrogen and 1,300,000 tons of phosphorus were lost annually by erosion and leaching in the United states. This was 28 times more nitrogen and 4 times more phosphorus than wee added in commercial fertilizers. Since phosphorus is fixed in rather insoluble forms in almost all soils and since a large part of the total nitrogen in soils is in organic form it is likely that most of the losses were as a part of the sediment. In fact, Smith (29) has shown that a very small part of the total nitrogen lost is in the form of nitrate. Data reported by Clarke (7) 50 years ego show that the nitrate nitrogen content of Southeastern streams range from .25 parts per million in the Cape Fear River at Wilmington, N. C. to 2.66 parts per million in the Mississippi et New Orleans. Analysis of some North Carolina streams in 1961-62 show values of 1.3, 1.7, and 3.0 parts per million for the Cape Fear, Pee Dee, and Neuse, respectively (23). These values are higher than those reported by Clarke but analysis published by the TVA (38) on a large number of streams in the Tennessee Valley area show nitrate concentrations in the range of those reported by Clarke; that is, less than 3 parts per million. This is well below the 45 parts per million of NO_3 which the Public Health Service set es the value that should not be exceeded in drinking water for infants.

One of the major problems is in determining how much of the total nitrogen in our waters comes from applied fertilizers. Smith (30) is quoted as follows: “Frequently uninformed writers imply, without proof, that all the nitrates and phosphates entering water come from agricultural fertilizers.” He reported that a study of 6,000 rural water supplies in Missouri showed that animal waste, improperly constructed shallow wells, and septic drainage were the main sources of contamination. He found some evidence that nitrate was reaching the water table when heavy applications were made on sandy soils. There was essentially no correlation between the amount of nitrogen applied and the amount of nitrogen in wells. There was, however, a correlation between the numbers of livestock and the contamination of water with nitrogen. He concluded that there is little evidence to support statements that fertilizer nutrients are contaminating water supplies. Many others have expressed essentially the same conclusion. For example, Hornig, et al. (12) stated, "The amount of nitrogen and phosphorus reaching natural waters that can be attributed to the fertilization of agricultural land is as yet unknown... There is little definitive information and further investigation is required.” He did point out that: “In rivers, pollution from excessive nutrients is most common below the waste discharge points of large cities. Lunin, et al. (16) expressed essentially the same idea as follows: “The committee is concerned with the lack of knowledge on eutrophication and enrichment phenomena. Specific questions posed were... 2. What are the sources of nitrate that may be present in a given water supply...”

There are others who believe that commercial fertilizers do serve as sources of nitrogen and phosphorus in streams. For example, Abelson (1) in discussing the eutrophication of Lake Tahoe stated, “It may become necessary to ban use of fertilizers on garden plots around the lake.” Willrich (44) listed 8 potential pollutants of agricultural origin and one of these was plant nutrients. Hasler and Swenson (11) in reporting on the First International Symposium on Eutrophication held et the University of Wisconsin in 1967 pointed out that drainage from farm land is second in importance as a nutrient source in temperate zones. They did, however, indicate that this wss principally from farm manure rather than from commercial fertilizers. Sawyer (26) reported that significant amounts of fertilizer materials reach aquatic areas through drainage from agricultural lands, particularly from surface runoff where poor land management practices exist. He stated that in general the application of commercial fertilizers to farm land does not cause significant fertilization of streams by surface runoff because most fertilizers are applied during the growing season, are tilled into the soil, and are used by the growing crops. In another article Sawyer (25) stated that from 235-262 pounds of phosphorus and from 3800-5200 pounds of nitrogen per year per square mile of agricultural lands were lost in drainage water. Englebrecht and Morgan (9) found that agricultural lands in Illinois lost about 225 pounds of phosphorus per square mile per year. Navone, et al. (21) studied the concentration of nitrogen in 700 ground water wells and reported that in some of the high level areas large amounts of nitrogen fertilizers,' sewage, or other wastes were being discharged to the ground water. There was, however, no quantitative estimate of the amount of nitrogen coming from commercial fertilizers. On the other -hand, Sylvester (36) stated that apparently a considerable portion of fertilizers applied to land, especially nitrogen and phosphorus, is being carried away by drainage waters. Stout and Burau (35) found high concentrations of nitrate nitrogen in wells within the lo-square mile Arroyo Grande Basin, near San Luis Obispo, California. They list the use of nitrogen-containing fertilizers on intensely cropped land as one of the factors contributing to the increasing amount of nitrate in the wells. A major factor was the nitrogenous wastes from the increasing population

Other implications that agricultural lands are sources of contamination of waters are in such publications as The Report of the National Resources Board (20) which showed that erosion and leaching losses of nitrogen and phosphorus were greater than the amounts removed by grazing and in harvested crops. That same publication reported an annual loss of approximately 548,000,000 tons of nitrogen carried annually by U. S. rivers to the oceans. There was, of course, no indication of how much came from agriculture and how much from industrial and municipal wastes which are dumped Into rivers. The latter are known to be exceedingly large. Furthermore, a large part of the total nitrogen and phosphorus lost by erosion is known to be carried by sediments in suspension rather than as the elements in solution.

It has been reported by several investigators, particularly Smith (27) and Smith and Miner (31) that high concentrations of nitrates in farm ponds can be traced to drainage from feedlots.

Losses of nitrogen and phosphorus from agricultural soils have been studied by a number of investigators using lysimeters. Most of these determined the losses through columns of soil not more than 3 or 4 feet deep and, hence, would not be representative of the losses through an entire soil profile. Lyon and Bizzell (17) have shown that nitrogen losses through a lysimeter 4 feet deep range from 2.5 lbs. from a grass sod to 69 lbs. of nitrogen per acre per year from bare soil. Phosphate losses were negligible. Stauffer (33) found that nitrogen losses from lysimeters varied from 1 to more than 100 lbs. per acre per year from different types of soils. Phosphorus losses were not determined. Jones (13) found that on some soils with certain crops no nitrogen was lost, whereas with other soils and other crops the losses were as high as about 50 lbs. per acre per year. McCants (19) and Terry and McCants(39), in North Carolina, have studied the leaching of applied nitrogen below the root zone in soils. They found that the magnitude of leaching was proportional to the amount of percolating water which in turn was affected by the hydraulic conductivity of the soil. More specifically, the hydraulic conductivity increased with an increase in percentage of large pores. They found also that the concentration of leached ions with depth gave a "normal" distribution curve.

Work on the concentration of nitrates in water supplies and the losses of fertilizer nitrogen to runoff water is currently being studied by Smith (28) and by Wagner (42) at the University of Missouri, and by Peterson (22) at the University of New Hampshire. The current status of the loss of fertilizer nutrients to water supplies has been summarized by Smith (29) as follows: "At present there is little evidence to support statements that fertilizer nutrients are contaminating water supplies. With excessive and improper use, however, nitrates could become a problem in the future when excess nitrogen is added to some soils."

Several publications (2, 5, 10, 18, 32, 41, 43) give a comprehensive review of fertilizer losses and the effects of fertilizers on water quality. They are recommended for a more detailed review than is given above. Organic wastes from agricultural products constitute a great potential for soil and water pollution. Cattle, swine, and poultry produce approximately 2,000,000,000 tons of waste per year in the United States. This includes the manure, bedding, dead carcasses, and slaughterhouse waste (37, 41). It is equivalent to more than 10 times the waste from the total human population of the

United States. Until rather recently this was disposed of on pasture land by grazing animals or was added to agricultural soils by farmers. The recent trend toward producing most livestock in partial or total confinement has increased the waste disposal problem. Confinement production of swine is well established with the confinement units containing as many as 10,000 hogs. Cattle are fed in feedlots which accomodate more than 100,000 head per year and, according to Taiganides (37), SO-80% of the'egg-laying hens and almost all of the broilers in the United States are raised under confinement. A feedlot with 60,000 cattle has the sewage equivalent to a city of more than 1,000,000 inhabitants. If manure is applied at the rate of 10 tons per acre the annual waste from a 60,000-capacity feedlot will cover approximately 10,000 acres.[1] In the Southern Great Plains most of the surface runoff from the feedlots is impounded in playas (14). Drainage from these constitute a potential source of pollution of ground water. Lehman, et al. (14) have studied seepage from these playas and have found that most of the nitrate was in the surface foot with only traces being found below the 2-foot depth. They concluded that most of the ground water contamination was through more permeable soils surrounding the playas. In another study by Stewart, et al. (34) the amount of nitrate found under corrals was extremely variable, ranging from almost none to more than 5,000 lbs. per acre in a 20-foot profile. The higher level is sufficient to raise the nitrate content, of 200-acre feet of water to 10 parts per million of nitrate nitrogen. They reported that denitrification was occurring under the feedlots and that most of the nitrate under the feedlots never reached the water table. In fact,

[1] U.S.D.A. Southwestern Great Plains Research Center, Bushland, Texas. In cooperation with the Texas Agricultural Experiment Station.

water from beneath corrals wee not noticeably higher in nitrate than water from under irrigated fields. This appears to be in conflict with the statement by Smith (29) that the nitrate in rural water supplies now appears to come mainly from waste disposal systems or from livestock feeding operations.

All animal waste must ultimately be disposed of on the land, in the water, or in the atmosphere (37). It would appear that the most feasible method of disposal would be on the land. In fact, Ludington (15) states that land spreading must be the method of ultimate disposal for chicken manure. Willrich (44) stated that land application appears more feasible than stockpiling, dehydrating, end composting. The amount that can be safely disposed of on a given area of land will be determined by the properties of the manure, the properties of the soil, the kind of crops to be grown on the land, and the existing climatic conditions. One of the major objectives of this project is to study this problem. Quigley (24) has pointed out that, "...there is no aspect of water pollution control in which research is needed more than in the area of agricultural pollution--not because agricultural pollutants are that much more difficult to treat than municipal or industrial wastes, but because they are so much more difficult to get to to treat."

References

1. Abelson, Philip H. 1966. water pollution. Science 152:1015.

2. Allison. F. E. 1966. The fate of nitrogen applied to crops. Adv. Agron.. 18:219-258. Academic Press, New York, N. Y.

3. Beaton, J. D. and S. L. Tisdale. 1969. Potential plant nutrient consumption in North America. Tech. Bul. 16, The Sulphur Institute, Washington, D. C.

4. Bower, C. A. and L. V. Wilcox. 1969. Nitrate content of the Upper Rio Grande as influenced by nitrogen fertilization of adjacent irrigated lands. Soil sci. Soc. Amer. 33:971-973.

5. Brady, Nyle C. 1967. Agriculture and the quality of our environment. AAAS Symposium 1966. Am. Ass". Adv. Sci. Pub. 85, Washington, D. C.

6. Byerly, T. C. et al. 1968. A national program of research for environmental quality--pollution in relation to agriculture and forestry. U. S. D. A. and The State Universities and Land Grant Colleges.

7. Clarke, F. W. 1920. The data on geochemistry. U. S. Geol. Survey Bul. 695. U. S. Gov't. Printing Office.

8. Commoner, Barry. 1968. Balance of nature. In Providing Quality Environment in Our Communities. Graduate School Press, U. S. Dept. Agr., Washington.

9. Englebrecht, R. S. and J. J. Morgan. 1959. Studies on the occurrence and degradation of condensed phosphates in surface waters. Sewage and Indus. Wastes 31:458.

10. Garman, W. H. 1969. Nitrogen facts and fallacies. (Excerpts from talk presented at the Annual Tennessee Fertilizer Short Course, Nashville, Tenn. Feb. 18, 1968) Plant Food Review, No. 1, 1969, pp. 15-20.

11. Hasler, Author D. and Marlette E. Swenson. 1967. Eutrophication. Science 158:278-282.

12. Hornig, Donald F., et al. 1965. Restoring the quality of our environment. Report of the Environmental Pollution Panel, President's Advisory Committee, Office of Science and Technology.

13. Jones, R. J. 1942. Nitrogen losses from Alabama soils in lysimeters as influenced by various systems of green manure crop management. Jour. Amer. Soc. Agron. 34:574-585.

14. Lehman, 0. R.. B. A. Stewart, and A. C. Mathers. 1970. Seepage of feed yard runoff water impounded in playas. Tex. Agr. Exp. Sta. W-944.

15. Ludington, David C. 1967. Properties of chicken manures affecting their disposal. In Agriculture and the Quality of Our Environment. AAAS Pub. 85. Nyle C. Brady, Editor.

16. Lunin, Jesse, et al. 1966. Interim report of the National Technical Advisory Committee on Water Quality Criteria to the Secretary of the Interior.

17. Lyon, T. L. and J. A. Bizzell. 1936. Lysimeter experiment, IV. Memoir 194, Cornell Univ. Agr. Exp. Sta.

18. Mackenthun, Kenneth M. 1965. Nitrogen and phosphorus in water. An annotated selected bibliography of their biological effects. U. S. Dept. of Health, Education, and Welfare.

19. McCants, C. B. 1962. Seasonal distribution of nutrients in soil under tobacco culture. Soil Sci. 94:36-43.

20. National Resources Planning Board 1934. Report of the Land Planning Committee. Supt. of Documents, U. S. Gov't. Printing Office.

21. Navone, R., J. A. Harmon, and C. F. Voyles. 1963. Nitrogen content of ground water in Northern California. Jour. Amer. Waterworks Ass". 55:615-618.

22. Peterson, N. K. 1966 (current research). Amount of movement of native and applied nitrogen in soils and drainage water. water Resources Res. Catalog Ref. 5.0660.

23. Phibbs, Edward J., Jr. 1964. Chemical and physical character of surface waters of North Carolina. N. C. Dept. of Water Resources, Division of Stream Sanitation and Hydrology. Bul I, Vol. VI.

24. Quigley, James M. 1967. Water quality and agriculture in the United States--an overall view. I" Agriculture and the Quality of Our Environment. AAAS Pub. 85. Nyle C. Brady, Editor.

25. Sawyer, C. N. 1947. Fertilization of lakes by agricultural and urban drainage. Jour. N. E. W. W. A. 61:109-127.

26. Sawyer, C. N. 1965. Problems of phosphorus in water supplies. Jour. Amer. Water Works Assn. 57:1431-1439.

27. Smith, G. E. 1964. Nitrate problems in plants and water supplies in Missouri. Paper presented at the Second Annual Symposium on the Relation of Geology and Trace Elements to Nutrition, 92nd. Ann. Meeting of Amer. Pub. Health Assn.

28. Smith, G. E. 1966 (current research). Accumulation of nitrates in plants and water supplies from nitrogen fertilization. Water Resources Res. Cat. Ref. 5.0619.

29. Smith, George E. 1967. Fertilizer nutrients as contaminants in water supplies. In Agriculture and the Quality of Our Environment. AAAS Pub. 85. Nyle C. Brady, Editor.

30. Smith. George E. 1967. Contamination of water by nitrates. Fertilizer Solutions Magazine, May-June 1967 Issue.

31. Smith. S. M. and J. R. Miner. 1964. Stream pollution from feed-lot runoff . Kansas State Board of Health Bul. Z-l.

32. Soileau, J. M. 1969. Effects of fertilizers on water quality. National Fertilizer Development Center, Tennessee Valley Authority, Muscle Shoals, Ala.

33. Stauffer, R. S. 1942. Runoff, percolate and leaching losses from some Illinois soils. Jour. Am. Soc. Agron. 34:830-835.

34. Stewart, B. A., et al. 1967. Distribution of nitrates and other water pollutants under fields and corrals in the Middle South Platte Valley of Colorado, U.S.D.A., ARS 41-134.

35. Stout, Perry R. and R. G. Burau. 1967. The extent and significance of fertilizer buildup in soils as revealed by vertical distributions of nitrogenous matter between soils and underlying water reservoirs. In Agriculture and the Quality of Our Environment. AAAS Pub. 85. Nyle C. Brady, Editor..

36. Sylvester, R. 0. 1961. Nutrient content of drainage water from forested, urban, and agricultural areas. Trans. of 1960 Seminar on Algae and Metropolitan Wastes. Dept. HEW, PHS Robert A. Taft Sanit. Eng. Center. Rept. W61-3.

37. Taiganides, E. Paul. 1967. The animal waste disposal problem. In Agriculture and the Quality of Our Environment. Nyle C. Brady, Editor.

38. Tennessee Valley Authority. 1963. Mineral quality of surface waters in the Tennessee River Basin. Rept. No. O-6392. Division of Water Control Planning, Hydraulic Data Branch, T.V.A. Knoxville, Tenn.

39. Terry, D. L. and C. B. McCants. 1968. The leaching of ions in soils. N. C. Agr. Exp. Sta. Tech. Bul. 184.

40. Verduin, Jacob. 1967. Eutrophication and agriculture in the United states. In Agriculture and the Quality of Our Environment. AAAS Pub. 85. Nyle C. Brady, Editor.

41. Wadleigh, C. H., et al. 1970. Soil science in relation to water resources development: IV. Responsibility of soil science in water quality improvement. Report of Water Resources Committee (SSSA, 5868, C. H. h'adleigh, Chm. SSSA 34:542-548).

42. Wagner, G. H. 1966 (current research). Fate of nitrogen. Water Resources Res. Cat. Ref. 5.0621.

43. Willrich, Ted L. 1966. Management of agricultural resources to minimize pollution of natural waters. Paper presented at the National Symposium on Quality Standards for Natural Waters, The Univ. of Mich.

44. Willrich, Ted. L. 1967. Disposal of animal wastes. In Agriculture and the Quality of Our Environment, AAAS Pub. 85. Nyle C. Brady, Editor.

232

(8) Previous Work -

Water quality surveys have been published for several states in the North-central Region. Examples of these are 1. excessive water fertilization (Report to the Water Subcommittee of the Wisconsin Natural Resources Committee of State Agencies) in 1967 (20), 2. Report of the Lake Erie Enforcement Conference Technical Committee in 1967(47),3. The Nebraska Water Quality Survey (41), and' 4. The Illinois State Water Survey (32). These reports have shown a deterioration in the quality of lakes, rivers and groundwater supplies. Hasler (29) estimated that 42% of the nitrogen reaching surface waters in Wisconsin came from the groundwater. Manured lands contributed nearly 10% of the nitrogen reaching surface waters. Concrete data obtained by surveillance of agricultural lands is largely missing from these reports.

Nitrogen:

The complexity of soil nitrogen cycles is well illustrated by the diagram in Figure 1. Commoner (14) suggests that modern technology has intruded into the nitrogen cycle at its most vulnerable point through the use of commercial nitrogen fertilizer. Referring to Figure 1, when nitrogen is added to the soil as inorganic nitrogen fertilizer, it may be incorporated into crops and subsequently removed, lost through leaching, adsorbed by clay minerals, chemically altered and subsequently volatilized, or incorporated into soil organic nitrogen supplies either as humus or microbial components. Agreement with Commoner is not universal, see Garman (23), White-Stevens (62) and Aldrich (5), and the disagreement points to our lack of knowledge of certain processes in the nitrogen cycle.

The two main processes involved in the movement of nitrogen in the soil, according to Gardner (22) are 1. convection of substances dissolved in the soil solution due to mass flow of the soil solution and 2. molecular or ionic diffusion due to concentration gradients. The extent and direction of movement

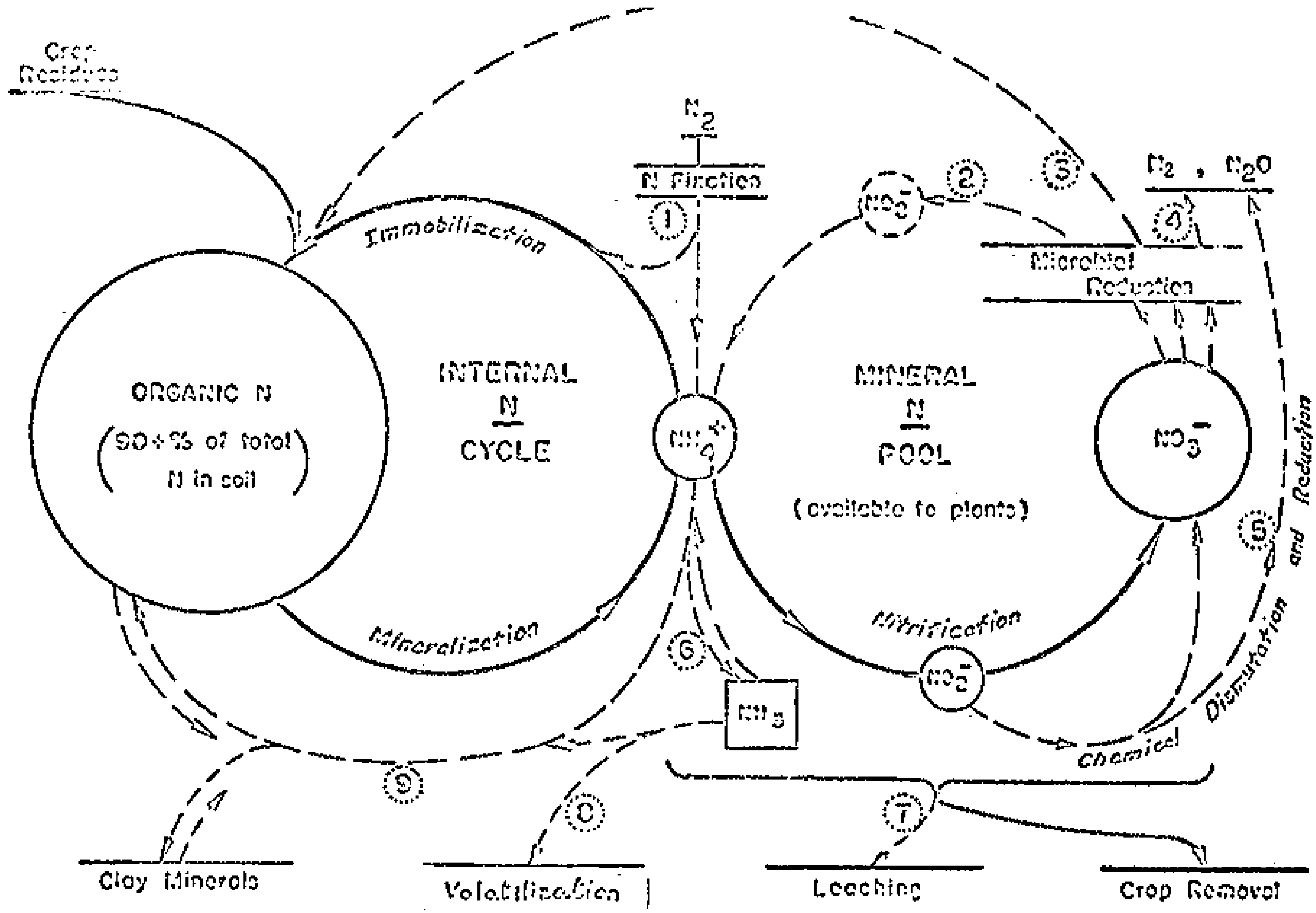


Figure 1. Pathways of nitrogen transformation in soil.

5234

by convection depends on the concentration of nitrogen in the soil solution and the pattern of movement of the soil solution. The ammonium form of soil nitrogen is normally adsorbed by the cation exchange complex and is not as susceptible to leaching as the nitrate form. Considerable information has been gained concerning the movement of nitrogen in soils and its subsequent loss to drainage water through lysimeter investigations. These studies have been summarized by Brown (12). They show that losses of nitrogen from soils that are not cropped intensively may approach 50 to 100 pounds of nitrogen per acre per year. This loss can be expected to be modified by soil type and agronomic practice.

It has been estimated that biological nitrogen fixation accounts for 100×10^6 tons of combined nitrogen entering the biosphere annually (18). This compares to 25×10^6 tons of commercial nitrogen used in a recent year as estimated by Garman (23). In spite of the apparent importance of the biological process, little definitive data exist on this contribution as has been recognized in the published aims of the Subcommittee on Production Processes of the International Biological Program (60). In a recent review, Delwiche (15) suggested that an average figure for terrestrial nitrogen fixation might be 10 lbs/acre per year. In arriving at this figure he included estimates on symbiotic nitrogen fixation, legume and nonlegume species, which have been shown to contribute as much as 200-300 lbs/acre per year (2) and fixation by free living organisms for which there is no sound basis to make a quantitative estimate (3). Work with ^{15}N in a few Canadian muck and mineral soils has shown that fixation in these soils was two or more times more rapid under anaerobic than under aerobic conditions, presumably implicating the importance of the free-living clostridia (13). In general, it is assumed, that because of the slow release of the biologically fixed nitrogen, terrestrial nitrogen fixation contributes less to nitrate pollution than do heavy applications of commercial nitrogen. However, in certain environments where fertilizers are not applied, such as alder forests, significant nitrate pollution of streams and waters has been observed (26,46).

In the aquatic environment, however, nitrogen fixation is 'probably of a more serious consequence since it will contribute additional nitrogen to an already nutrient rich lake. Dugdale and Dugdale (19) have shown that nitrogen fixation is correlated with bluegreen algal blooms in a Pennsylvania lake. A recent report has suggested that nitrogen fixation accounts for 14% of the annual nitrogen input in Lake Mendota, Wisconsin (8). However, this figure may be low for many lakes as Goering and Neess (25) found insignificant nitrogen fixation in the mildly eutrophic Lake Mendota compared to the eutrophic Lake Wingra, Wisconsin.

Recently, Schollhorn and Burris (49) and Dilworth (16) independently recognized that nitrogenase reduces acetylene quantitatively to ethylene. Since those announcements, Stewart et al. (57) and Hardy et al. (27) have developed techniques for an <u>in situ</u> assay of nitrogen fixation by measuring the ethylene produced with a gas chromatograph. The former have shown that the acetylene reduction directly parallels ^{15}N incorporation. Evidence from several workers has shown that all previously known nitrogen fixing species so far examined have reduced acetylene to ethylene (27, 51, 56). The major advantages of the technique appear to be the high sensitivity (10^6 greater than ^{15}N and 10^6 times greater than Kjeldahl analyses) and inexpensiveness when compared to ^{15}N analyses.

The loss of nitrates from certain anaerobic environments is generally attributed to denitrification. Though this process has been known since the 19th century, little quantitative data exist to verify that this process is important to the nitrogen budget of soils and lakes. Broadbent and Clark (9) and Allison (4) have reviewed over 30 studies in which ^{15}N was added to the soil and have found, on average, a nitrogen deficit of 15 to 20% which is attributed generally to "gaseous losses." In certain studies, loss of 50% of added nitrogen was attributed to denitrification (9). In more recent work on Australian soils, denitrification was affected markedly by position in the profile (37).

Environmental conditions shown to be important in denitrification have been reviewed by Broadbent and Clark (9). Low O_2 tensions and readily decomposable organic matter are essential for denitrification to occur. The pH of the soil appears to affect the gaseous products formed with, generally, more N_2O being evolved in soils of pH less than 7.0.

Studies in the aquatic environments, though less extensive, suggest that denitrification results in significant losses. Kuznetsov (36) presented data which suggested that about one third of the nitrogen in a lake was lost to denitrification. Recently, studies with ^{15}N in on Alaskan lake showed production of N_2 at the rate of 80 &liter/day during the anoxic period (24). More recently, Brezonik and Lee (8) estimated indirectly that the rate of denitrification in the hypolimnion of Lake Mendota was 8 to 26 μg/liter/day. These authors calculated that the loss of nitrogen by denitrification was 11% of the annual input of nitrogen, though their budget left 67% of the nitrogen loss unaccounted for and they attributed this to sediment deposition.

Phosphorus:

Phosphorus is necessary to sustain plant and animal life in both terrestrial and aquatic environments. Enrichment of waters with phosphorus nay lead to algae "blooms" end in severe cases or with prolonged exposure nay lead to eutrophication of water. Thus, according to Mackenthun (38) "reduce phosphorus in waste-water sources" has become a slogan to those who would decelerate cultural eutrophication.

Owens end Wood (44) point out that a distinction must be made between natural eutrophication which is generally an inherent process in the aging of impounded waters and artificial eutrophication resulting from the discharge of domestic and industrial waste waters, and runoff and leaching from heavily fertilized agricultural land. Swayer (58) reported that nuisance blooms of phytoplankton would be expected if lakes contained more than 10 ppb phosphorus. There have been many studies conducted to determine the equilibrium level of soil solutions with respect to phosphorus. An example of these studies is the work of White and Beckett (61) who have reported lime-phosphate potentials. Calculations from these potentials would indicate that soil solutions would exceed the 10 ppb phosphorus necessary to produce nuisance blooms. Even so, because of the low level of phosphorus in soil solutions, the major source of phosphorus movement from agricultural lands into water resources may well be in the form of eroded soil particles which result in sediment formation in streams and lakes (1, 21, 35, 59).

Many studies have been conducted in the United States on movement of fertilizer that has been topdressed on soils. On the surface these studies appear very contradictory. Brown (11), Brown and Munsel (10), Doll et al. (17), Metzger (40), and Schaller (48) all showed little movement of P. But al' of their experiments were conducted on medium to fine textured soils. Neller (42), Heck (31), Jones et al. (33), Spencer (52), Spencer (53), and Stephenson and Chapman (54) all showed some movement of added phosphorus. Although tie soils for the most part were not well characterized, it appeared that these workers were studying sandy soils. Some of the studies showed that the rate of phosphorus applied had a large effect on movement. This implies that a soil has a definite fixing capacity for phosphorus after which movement will occur more rapidly.

It has been concluded that the primary mineral source of phosphorus in soils is apatite. Aluminum and iron phosphates are believed to be of secondary origin, forming from both phosphorus fertilization and weathering of calcium phosphate minerals (34). It was found that the clay size fraction contained much higher concentrations of aluminum and iron phosphates as compared to the silt and sand fraction. But the silt fraction contained almost as much calciw phosphate as the clay fraction. Olsen and Watanabe (43) found that phosphorus adsorption capacities correlated well with the ethylene glycol retained by soil indicating that phosphorus adsorbed was by the finer soil fractions. Thus heavy applications of phosphorus fertilizer may be expected to produce adsorbed phosphorus on the clay fraction which is susceptible to being moved a greater distance during erosion by water.

In soils several forms of phosphorus co-exist with the level of phosphorus in solution being controlled by the least soluble compound (37). Bailey (6) states that the pH of the soil system is a dominant factor in phosphorus fixation. Minimum fixation occurs at soil pH 6.5 to 7.0 with fixation in the acid range by hydrous oxides of aluminum, iron and manganese and by soluble aluminum, iron and manganese. At pH's above 7.0 fixation is mainly as calcium phosphates.

Harter (28) has reported data showing that lake sediments are capable of adsorbing a large amount of phosphorus. But lake waters below the point of reduced aeration are known to be high in phosphorus. It is suspected that adsorbed phosphorus is available to algae in aquatic systems, Abbott (1). Hayes and Phillips (30) reported that the phosphorus equilibration pattern and rate between mud and water was the same in natural Jenkin sampler cores, in artificial cores and in battles in which dredged surface mud was packed by centrifuge. They concluded that any specific natural physico-chemical or bacteriological layering of the surface muds of lake5 is relatively unimportant in phosphorus exchange. They also found that bacteria did have a remarkable ability to hold phosphorus in solution.

Some studies have indicated that phosphorus release from sediments depends upon certain physical and chemical conditions; thus, tightly bound phosphorus may be released when conditions change, Zicker et al. (63), and Stevenson (55). Patrick (45) has shown that redox potentials of less than +200 m.v. give rise to increased levels of extractable phosphorus from a Crowley silt loam. This observation is compatible with data from Beacher (7) and Shapira (50) who found increased extractcblc soil phosphorus in submerged soils.

References:

1. Abbott, W. 1957. Unusual phosphorus sources for plankton algae. Ecology. 38:152.

2. Alexander, M. 1961. Introduction to Soil Microbiology. John Wiley & Sons, New York.

3. Allison, F. E. 1965. Evaluation of incoming and outgoing processes that affect soil nitrogen. In W. V. Bartholomew and F. E. Clark (cd.) Soil nitrogen. Amer. Soc. Agron., Madison, Wis. pp, 573-606.

4. Allison, F. E. 1966. The fate of nitrogen applied to soils. Adv. in Agron. 18:219-258.

5. Aldrich, S. R. 1970. Is nitrogen fertilizer a threat to environmental quality? Presented at 12th Sanitary Engineering Conference, University of Illinois, February 11-12, 1970.

6. Bailey, G. il. 1968. Role of soils and sediments in water pollution control. Part 1. Reactions of nitrogeneous and phosphatic compounds with soils and geologic strata. U. S. Department of the Interior. Federal Water Pollution Control Administration.

7. Reacher, R. L. 1955. Sampling and analysis of paddy soils. FAO International Rice Commission Background Paper. 5th Meeting of Working Party on Fertilizers, Malaya.

8. Brezonik, P. L., and G. F. Lee. 1968. Denitrification as a nitrogen sink in Lake Mendota, Wisconsin. Environ. Sci. and Technol. 2:120-125.

9. Broadbent, F. E., and F. Clark. 1965. Denitrification. In W. V. Bartholomew and F. E. Clark (ed.) Soil nitrogen. Amer. Soc. Agron. Madison, Wis. pp. 344-359.

10. Brown, B. A., and R. L. Munsell. 1963. Penetration of surface applied lime and phosphate in the soil of permanent pastures. Storrs Agr. Exp. Sta. Bul. 186.

11. Brown, L. A. 1935. A study of phosphorus penetration and availability in soil. Soil Sci. 39:277-287.

12. Brown, M. A. 1965. Leaching losses of nitrogen. Soils and Fertilizers Res. Branch, Tennessee Valley Authority, Wilson Dam, Ala. Publ. No. T 65-1 SF.

13. Chang, P. C. and R. Knowles. 1965. Non-symbiotic nitrogen fixation in some Quebec soils. Can. J. Microbiol. 11:29-38.

14. Commoner, B. 1968. Threats to the integrity of the nitrogen cycle: nitrogen compounds in soil, water, atwsphere and precipitation. Presented at the Annual meeting of the American Association for the Advancement of Science. Dallas, Texas.

15. Delwiche, C. C. 1965. The cycling of carbon and nitrogen in the biosphere. In C. 1:. Gilmour and O. N. Allen (cd.) Microbiology and soil fertility. Oregon State Univ. Press, Corvallis, Oregon.

16. Dilworth, I.!. J. 1966. Acetylene reduction by the nitrogen-fixing preparations from *Clostridium pasteurianum*. Biochem. Biophys. Acta 127:285-294.

17. Doll, E. C., A. L. Hatfield, and J. R. Todd. 1959. Vertical distribution of topdressed fertilizer phosphorus and potassium in relation to yield and composition of pasture herbage. Agron. J. 51:645-648.

18. Donald, C. ii. 1960. The impact of cheap nitrogen. J. Australian Inst. Agr. Sci. 26:319.

19. Dugdale, V. A., and R. C. Dugdale. 1965. Nitrogen metabolism in lakes. III. Tracer studiess of the assimilation of inorganic nitrogen sources. Limnol. and Oceanogr. 10:53-57.

20. Excessive Water Fertilization. 1967. Report to the Water Subcommittee of the Wisconsin Natural Resource Committee of State Agencies.

21. Fippin, E. O. 1945. Plant nutrient losses in silt and water in the Tennessee River system. Soil Science 60:223-239.

22. Gardner, W. R. 1965. Movement of nitrogen in soil. In Soil Nitrogen. Agron. Monograph No. 10. American Soc. Agron. Press, Madison, Wis.

23. Garman, W. H. 1969. Some nitrogen facts and fallacies. Presented at the Annual Tennessee Fertilizer Short Course, Nashville, Tennessee.

24. Goering, J. J., and V. A. Dugdale. 1966. Estimates of the rates of denitrification in a subarctic lake. Limnol. and Oceanogr. 11:113-117.

25. Goering, J. J., and J. C. Neess. 1964. Nitrogen fixation in two Wisconsin lakes. Limnol. and Oceanogr. 9:530-539.

26. Goldman, C. R. 1961. Ecology. 42:282-288.

27. Hardy, R. W. F., R. D. Holster., E. K. Jackson, and R. C. Burns. 1968. The acetylene-ethylene assay for N_2 fixation: laboratory and field evaluation. Plant Physiol. 43:1185-1207.

28. Harter, R. D. 1968. Adsorption of phosphorus by lake sediments. Soil Sci. Soc. of Amer. Proc. 32:514-518.

29. Hasler, A. 1969. Cultural eutrophication is reversible. Bio. Sci. 19:425-431.

30. Hayes, F. R., and J. E. Phillips. 1958. Lake water and sediment. IV. Radiophosphorus Equilibrium with Mud, Plants, and Bacteria under Oxidized and Reduced Conditions. Limnol. and Oceanogr. 3:459-475.

31. Heck, A. F. 1934. Phosphate fixation and penetration in soils. Soil Sci. 37:343-356.

32. Illinois State Water Survey. 1968.

33. Jones, D. W., H. Gammon, and P. B. Forbes. 1951. Leaching of fertilizer phosphorus in acid sandy soils as affected by lime. Florida Agr. Exp. Sta. Circ. S-32.

34. Juo, A. S. R., and D. G. Ellis. 1968. Particle size distribution of aluminum, iron and calcium phosphates in soil particles. Soil Sci. 106:374-380.

35. Keup, L. E. 1968. Phosphorus in flowing waters. Water Research 2:373-386.

36. Kuznetsov, S. I. 1959. Die Rolle der Mikroorganismen in Stoffkrieslauf der Seen. VEB Deutscher Verloy der Wissenschaften, Berlin.

37. Lindsey, W. L., and E. C. Moreno. 1960. Phosphate phase equilibria in soils. Soil Sci. Soc. of Amer. Proc. 24:177-182.

38. Mackenthun, K. M. 1968. The phosphorus problem. J. of Amer. Water Works Assoc. 60:1047-1054.

39. McGarity, J. W., and R. J. K. Myers. 1968. Denitrifying activity in solodized solonetz soils of Eastern Australia. Soil Sci. Soc. Amer. Proc. 32:812-817.

40. Metzer, W. H. 1934. Distribution of fertilizer residues in the soil after fourteen years of a fertilizer experiment with alfalfa, J. Amer. Soc. Agron. 26:620-625.

41. Nebraska Water Quality Survey. 1965. Bull. E. C. 65-165. Extension Service Univ. of Neb., College of Agric. and Home Ec. and U.S. Dept. of Agric.

42. Neller, J. R. 1947. Mobility of phosphates in sandy soils. Soil Sci. Soc. Amer. Proc. 11:227-230.

43. Olsen, S. R., and F. S. Watanabe. 1957. A method to determine a phosphorus adsorption maximum of soils as measured by the Langmuir isotherm. Soil Sci. Soc. of Amer. Proc. 21:144-149.

44. Owens, M., and G. Wood. 1968. Some aspects of the eutrophication of water. Water Research. 2:151-159.

45. Patrick, W. H., Jr. 1968. Extractable iron and phosphorus in a submerged soil at controlled redox potentials. 8th Intern. Congress of Soil Sci. Bucharest, Romania. 1964. IV:605-609.

46. Peterson, N. K. 1968. Effect of alder on amount of inorganic nitrogen in the ground water. Agron. Abstr. 96.

47. Report of the Lake Erie Enforcement Conference Technical Committee in 1967.

48. Schaller, F. W. 1946. The downward movement of lime and superphosphate in relation to permanent pasture fertilization. Soil Sci. Soc. Amer. Proc. 5:162-166.

49. Schollhorn, R., and R. H. Burris. 1966. Study of intermediates in nitrogen fixation. Federation Proceed. 24:710.

50. Shapira, R. E. 1958. Effect of flooding on availability of phosphorus and nitrogen. Soil Sci. 85:190-197.

51. Silver, W. S. 1967. Biological nitrogen fixation. Sci. 157:100-102.

52. Spencer, W. F. 1953. Phosphatic complexes in the soil--their effect on retention and availability of nutrient cations. Florida Agr. Exp. Sta. Annual Report.

53. Spencer, W. F. 1957. Distribution and availability of phosphates added to a Lakeland fine sand. Soil Sci. Soc. Amer. Proc. 21:141-144.

54. Stephenson, R. E., and H. D. Chapman. 1931. Phosphate penetration in field soils. Jour. Amer. Soc. Agron. 23:759-770.

55. Stevenson, W. 1949. Certain effects of agitation upon the release of phosphorus from mud. J. Mar. Biol. Assoc. U. K. 23:371-380.

56. Stewart, W. D. P., G. P. Fitzgerald, and R. H. Burris. 1968. Acetylene reduction by nitrogen fixing blue-green algae. Arch. Mikrobiol. 62:336-348.

57. Stewart, W. D. P., G. P. Fitzgerald, and R. H. Burris. 1967. <u>In situ</u> studies on N_2 fixation using the acetylene reduction technique. Proc. Nat'l Acad. Sci. 58:2071-2078.

58. Swayer, C. N. 1947. Fertilization of lakes by agricultural and urban drainage. J. Engl. Wat. Wks. Assoc. 61:109-127.

59. Sylvester, R. O. 1961. Nutrient content of drainage water from forested, urban and agricultural areas. Algae and metropolitan waste, U.S. Public Health Service, SEC TRW 61-3, pp. 80-87.

60. U.S. Committee for the International Biological Program. January, 1967. Program statement of the subcommittee on production processes.

61. White, R. E., and J. H. T. Beckett. 1964. Studies on the phosphate potentials of soils. Part 1 - The measurement of phosphate potential. Plant and Soil 10:1-15.

62. White-Stevens, R. 1970. Farm chemicals and water pollution. Presented at 1970 Midwest Fertilizer Conference.

63. Zicker, E. L., K. C. Berger and A. D. Hasler. 1956. Phosphorus release from bog lake muds. Limnol. and Oceanogr. 1:296-303.

SOME ASPECTS OF SOILS AND CIVILIZATIONS AT SARDIS, TURKEY

Gerald W. Olson[1]

The purpose of this paper (accompanied by slides) is to illustrate one example of the benefits that can be derived from using soil information and maps in intensive interdisciplinary studies. Archaeology is a science which helps man learn more about himself in his origins. Soil science can contribute to archaeology by providing data about soil properties in the environment that influenced ancient man (Olson and Puleston, 1,970; Olson, 1970). These cooperative studies become increasingly relevant in planning, because the trends of the past provide data which can be used to help predict the future.

A brief description of Sardis is given in footnote 2. Figure 1 locates the archaeological excavations in relation to the topography. Soils were described, sampled, and mapped around the Lydian, Greek, Roman, and Byzantine ruins in a cooperative project of the Archaeological Exploration of Sardis, sponsored by Cornell University and the Fogg Art Museum of Harvard University.[3] One hundred and seven soil samples were collected along with soil profile descriptions from about 55 sites to characterize the soils and their archaeological and historical significance. A soil map of the central city area WAS made at a scale of 1:2,000 on a base map with a contour interval, of five meters. Samples were analyzed by the soil fertility laboratory at Cornell University and by the laboratory of the Soil and Fertilizer Research Institute in Ankara.

In figure 1, the valley to the north is occupied mainly by soils formed in alluvial sediments. Point 5 on the map marks the location of a large Roman building now nearly covered with more than 20 feet of sediments deposited above its base. Archaeological and soils investigations around this building indicate that erosion has probably been greatly accelerated since Roman times, when man even then was overgrazing the landscape. The modern water table has risen above the original level of the base of the building, probably due to increasing use of irrigation waters in the valley. Some soils in the valley appear to have salinity and alkalinity problems.

Points 2, 10, and 13 in figure 1 have ruins covered by flood deposits and landslides. Soils formed in the landslide materials have low contents of organic matter in surface horizons. Point 13 marks the location of one of the largest known Greek marble temples. After construction in the third century B.C., the temple site experienced several earthquakes. In the ninth century A.D., a landslide covered the ruins to a depth of about 20 feet.

Soils on the Acropolis, around point 1.4, have been severely eroded in many places. A few spots have aeolian deposits where sparse vegetation caught sand particles. Some of the Byzantine walls are covered with shallow soils formed from construction materials; other ruins are covered with deeper soils developed in fill materials. A few places have soils developed under pine litter with large amounts of organic matter in their surface horizons.

Some places on ridges radiating out from the Acropolis have soils with well developed platy structures resulting from soil movement and landslides. Soil properties characteristic of landslides are numerous around point 15 in figure 1. Many soils have large contents of mica flakes which contribute to sliding of the soil mass, especially when it is wet. Valleys between the ridges generally have gravelly soils formed in torrent deposits, containing considerable amounts of cut marble stones, pieces of brick, pottery sherds, tile fragments, and other artifacts, fallen from the Acropolis, in many places.

The richest soils, containing considerable amounts of gold flakes, occupy the narrow alluvial floodplain of the Pactolus river. These soils were the source of the wealth of the Lydian king Croesus, reputed to be the world's richest king. A Lydian altar, west of the Temple of Artemis (point 13), appears to have been built on au Al horizon more than 2,000 years ago. Soil studies were important in providing information about archaeological strata, pottery sources, building materials, and origin of anthropic landforms (mounds). Archaeological studies were of value in determining dates of landslides, ages of soil materials, evidences of past land uses, and directions and magnitudes of soil movements. Use of soil information in the future at Sardis can help to preserve the monuments and achieve an improved environment through landscape design.

FOOTNOTES

1/ Asst. Prof. of Soil Science in Resource Development, 152 Emerson Hall, Cornell University, Ithaca, New York 14850. This paper was prepared for presentation as part of the report of Committee XIV on Environmental Soil Science to the National Technical Work-Planning Conference of the Cooperative Soil Survey in Charleston, South Carolina, on January 25-28, 1971.

2/ Sardis is a ruined city about 45 miles east of Izmir, Turkey. It was the capital of the ancient kingdom of Lydia, the western terminus of the Persian royal road described by Herodotus, a center for administration under the Roman Empire, and the metropolis of the province of Lydia in later Byzantine times. It was important because of its strategic military location, its position on an important highway leading from the Anatolian plateau to the Aegean coast, and its access to the wide and fertile plain of the Gediz river valley. Sardis was a city of reference in the Iliad, Aleman, and the Bible. It was captured by the Cimmerians in the seventh century B. C., by the Persians in the sixth century B. C., by the Athenians in the fifth century B. C., and by Antiochus the Great in the third century B. C. It was destroyed by an earthquake in A.D. 17, but rebuilt under Tiberius. The fort on the citadel was handed over to the Turks in 1306. It was captured by Timur in 1402. The latest conflicts at Sardis were battles of the Greek-Turkish war in the first quarter of the twentieth century. Ruins at Sardis have been excavated since 1958 by a Cornell-Harvard expedition.

3/ Acknowledgments for assistance are gratefully extended to G.M.A. Hanfmann of Harvard University, M. Ozuygur of the Soil and Fertilizer Research Institute in Ankara, and T. Greweling of Cornell University. The grant for travel was made under the Humanities Grant No. 11-70-3966 for Archaeological Exploration of Sardis through Harvard University, and other contributions to the expenses of the project were borne by the Department of Agronomy of Cornell University and the Sardis Expedition Fund of Harvard University.

REFERENCES

Olson, G. W. and D. E. Puleston. 1970. Examples of ancient and modern use and abuse of soils. New York's Food and Life Sciences 3 (2):27-29.

Olson, G. W. 1970. Field report on soils of Sardis, Turkey; a description of fieldwork and research orientation in a study of the soils environment around the ancient Lydia", Greek, Roman, and Byzantine ruins. Agronomy Mimeo 70-S. Cornell, University, Ithaca, New York. 9 pages.

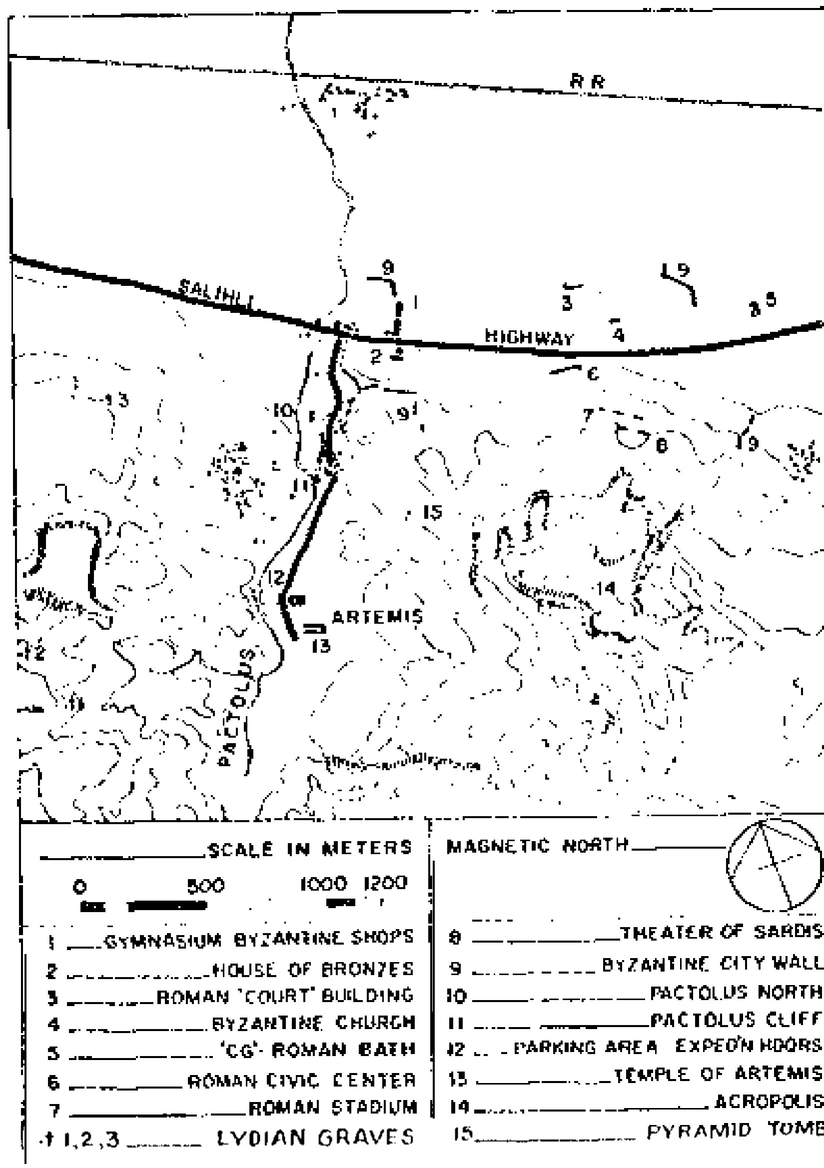


Figure 1. **Plan of Sardis excavations.**

CLOSING REMARKS

We have had a good meeting--one of a long series of technical work-planning conferences. Much of the first edition of the Soil Survey Manual was worked out in these, and even more of the second edition. Now we are at it again for a third.

Perhaps more than at most, this conference has gone deeply into physics, mineralogy, chemistry, hydrology, and other natural sciences. This can be good. Yet despite the great importance of economics, we have had far too little discussion here of the basic principles of that field as applied to our Work.

The Soil Survey has no greater opportunity in our own country than to help people with town-and-country planning. And these principles are vitally important in other countries looking forward to efficient agricultural systems that must include large industrial sectors. As development goes forward, numbers of farm workers decline and numbers of other agricultural workers increase. As with us in the United States, people in other countries must plan soil use with this in mind to have good economic, physical, biological, social, and cultural environment,

We have also discussed the history of soil science, perhaps especially some of the older ones of us. This too is good. We do need to know this history. Yet we must avoid being bound by it in the face of new data and new opportunities to help people with their current problems.

This is probably the last of these conferences at which I preside. Naturally, I shall remain deeply interested.

You have my best wishes.

carry on.

Charles E. Kellogg
Deputy Administrator for Soil Survey