Expert Committee on Soil Survey

Proceedings of the Fourth Annual Meeting

Victoria, British Columbia
19-23 April 1982

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The Expert Committee on Soil Survey is a subcommittee of the Canada Committee on Land Resource Services, which is part of the Canadian Agricultural Services Coordinating Committee systems.

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SUMMARY

These proceedings are a record of the current stages of development of selected technical subjects related to the methodology of conducting soil surveys in Canada. It includes contributions to the improvement of methods for classifying soils, for interpreting soil information, for handling and storing large amounts of soil data, and for evaluating the extent of degradation of soils.

RÉSUMÉ

Ce procès-verbal est une photo de l'état d'avancement de certains sujets techniques reliés à la méthodologie d'exécution des prospections pédologiques au Canada. Il comprend certaines contributions à l'amélioration des méthodes de classification des sols, de traitement et de stockage d'un grand nombre de données pédologiques, d'interprétation de ces données et d'évaluation du degré de dégradation des sols.

CONTENTS

Reports presented at technical working group sessions.

BROCHURES FOR NONAGRONOMIC INTERPRETATIONS

and OTHER TOPICS

R. E. Smith

This second report of the Working Group on Brochures for Non-Agronomic Interpretations and Other Topics deals mainly with the activities related to the production and publication of non-technical, "Soil Surveys Can Help You" publicity brochures. It does not and, as pointed out in the first working group report, cannot deal adequately with the problem of developing guidelines for the content and format of technical bulletins explaining soil survey technology to technical people outside of the soil survey field. These "second generation" technical bulletins require research and development directed at the improvement of land evaluation and interpretation for specialized areas, in particular, for forestry, wildlife habitat, engineering uses and urban and recreational land-use planning. Technical bulletins for such purposes also require a regional approach, like the current series being generated by the Terrestrial Studies Branch of the B.C. Ministry of Environment. Development of a set of national guides would, in our view, not only be inappropriate, but would be inadequate in light of needed continuing technical interfacing between soil survey interpretations specialists and non-survey technologists.

The development of national survey methods and procedures handbooks, on the other hand, are currently being undertaken by other working groups well qualified to develop the type of handbooks and technical bulletins required to explain and apply survey methodology and information.

The working group, therefore, has as a result of the above conclusions, defined for itself the remaining tasks of:

1. Developing a format and content for preparation and production of non-technical, layman-oriented publicity brochures.

2. Identifying future regional (unit) activities to more aggressively publicize the program of soil survey.

3. Developing recommendations for internal technical development and for related R & D programs and policies to be directed to ECSS.

1. BROCHURES

1.1 Format

It was decided by the working group to adopt, as closely as possible, the style and format adopted by the Soil Conservation Service, U.S.D.A. for their series of such brochures, keeping in mind the need for bilingual presentation. The message in their series of brochures keyed on the principal message of how soil survey information could help or benefit specific groups of users with their land management and land use planning concerns.

The format and content of their brochures, presented in a very personalized, visual manner, employing very basic non-technical language consists of:

1.11 A Title Page that graphically identifies the target user, e.g. "Land Use Planners"; the principal message "Soil Surveys Can Help"; and the sponsoring government agency responsible for the publication of the brochure. In our case, by the "Expert Committee on Soil Survey, Canada" would be more appropriate, since it is the recognized coordinating body for all federal and provincial soil survey activities in Canada.

1.12 A Text that is written in concise, personalized, basic language avoiding the use of technical jargon. Language, however, is adjusted somewhat to reflect the varying capability of certain user groups to handle technical information, e.g. a design engineer as opposed to a government agency planner as opposed to a private citizen or farmer interested in purchasing a lot or farm.

It attempts to catch the attention of target users by flagging several soil properties and natural hazards that may profoundly affect the narrow interest of target user concerns, e.g. unstable soil conditions affecting construction or building site location on Leda clay near St. Jean, Quebec.

It provides, in a sentence or two, information on how soil surveys can help the user cope with his land use concerns or problems.

It describes, very briefly, what is contained in soil survey maps and reports.

It indicates where soil survey information can be obtained.

The title page, text and illustrations are all accommodated on a 4-inch, roll-folded pamphlet that is 9 x 16 inches in overall dimension. The bilingual Canadian version would require fewer illustrations or a shorter message if the size of the pamphlet, for cost reasons, is restricted to this size as well.

1.13 Illustrations. The use of illustrations in the SCS brochures key not only on flagging several natural hazards and problems caused by specific kinds of soil properties, but also on the positive effects of selecting appropriate sites or soils for specific uses. Approximately 6 or 7 prints are currently being planned to illustrate each brochure. Production costs will dictate the final number used.

1.2 Production Logistics and Progress

Table 1 summarizes current progress on development and production of identified target area brochures. It should be noted that the brochure

Table 1. Brochure Production

	Brochure	Authors	Text	Illustrations and Graphics
1.	Soil Surveys Can Help You	J.H. Day, LRRI	Completed, edited, ready for translation and printing	Number and kind are yet to be determined.
2.	Farmers and Ranchers	C. Acton, Ont.	Completed, edited, ready for translation and printing	To be selected.
3.	Land Use Planners	T. Vold, P. Dakin, T. McKinnon, B.C.	Completed, edited, ready for translation and printing	7 illustrations, local to B.C., may require one or two substitutes to be more suitable nationally, captions required.
4.	Home Buyers	L. Van Vliet, B.C.	Completed, edited, ready for translation and printing	7 very suitable color slides available showing structural failure due to unstable soils, permafrost and high shrink-swell and flooding damage.
5.	Recreation Planners	M. Langman, Man.	Completed, edited, ready for translation and printing	3 or 4 available but scope not sufficiently wide enough for national needs.
6.	Septic Filter Fields	K. Webb, Nova Scotia	Completed, edited, ready for translation and printing	To be selected - very difficult to find suitable photos; probably requires graphics.
7.	Engineers	W. Michalyna, Man. M. Langman, Man.	Completed, edited, ready for translation and printing	To be selected.
8.	Foresters	G. Pierpoint, K. Jones, Ont.	Completed, edited, ready for translation and printing	To be selected.
9.	CanSIS	B. Kloosterman, LRRI, Ottawa	Completed, edited, translated, ready for printing	

on Geologic and Natural Hazards has been dropped from the list, since it does not address itself to a specific user group. The general brochure on Soil Surveys is not aimed at a specific user group but is, however, specific in regard to the nature of the program in Canada. The CanSIS brochure, while not the responsibility of the working group, is in the table to provide update on its production.

All texts covering the eight target user areas identified in the 1981 workshop meeting have been written, edited and approved for translation and printing by all participating provinces.

Some difficulty in obtaining suitable color slides or prints for some brochures, in particular for Septic Fields and Recreation Planners, has been encountered. It is apparent also that much overlapping exists between various brochures, since the emphasis of most are orientated toward engineering, and urban and recreational land-use planning concerns. The publishing of all brochures at a reasonable cost may dictate to a considerable extent, the final numbers and kinds of illustrations ultimately employed. However, it is our plan to provide Research Program Services sufficient material to give them some flexibility in producing a suitable bilingual product. John Day, with the help of the Cartographic Unit, will provide the liaison with RPS to ensure final layout and production.

The current estimated cost for approximately 25,000 copies of each brochure ranges from $1,000 to $6,000 depending on format and content. The estimated cost of producing 4,000 copies of the CanSIS brochure is approximately $1,400 to $1,500.

2. FUTURE REGIONAL PUBLICITY ACTIVITIES

While the brochures are aimed at special groups of users, they are by no means the sole answer to the problem of making soil survey more visible and subsequently, a more effective service. Other useful activities within our current capability to undertake include:

2.1 Map Indexes, Catalogues and Newsletters, etc.

Distributing catalogues of publications, indexes of available soil map coverage and newsletters on an annual, biannual or quarterly basis is an immediate way of improving the dissemination of soil survey information. While multicolored indexes to soil surveys published from time to time by the Cartographic section of LRRI are useful, they are invariably out-of-date and consequently of limited value by the time they are released for general distribution. A more responsive system of communication at the local or provincial level is required. The working group recommends that a greater effort to improve communications through this means be undertaken by all units.

2.2 Workshops and Soil Survey Extension Activities

As pointed out in the 1981 report, a greater effort is required by individual surveyors, working in cooperation with full-time provincial extension specialists and other provincial agencies concerned with the problem of applying and utilizing soil survey information to go out and sell surveys. It would be useful to plan and conduct public and user agency meetings, workshops and field tours at the local level, as part of normal survey procedure to introduce survey projects, explain procedures and methods and to provide instruction on the uses of published soil surveys. The working group recommends, as it did in 1981, that an increase in such activities be undertaken by all units.

2.3 Second Generation Technical Bulletins

John Day has raised the question of having the current working group deal with the development and production of more technical bulletins explaining soil survey methodology to technical people outside of Soil Survey. The working group believes that such publications are the concern of specialized working groups within ECSS having much greater expertise at their disposal to deal with such matters. It sees no merit in attempting to work up a "standard model" or suitable format for national or regional presentation that such bulletins should follow. Stand alone products such as small scale thematic soil maps, more technical bulletins explaining survey methodology and procedures, in terms of mapping systems employed, how soil interpretations for various specific uses are made, etc. are all very important in shedding light on a little known service and their production should be encouraged. But the working group sees no advantage in imposing, in all probability, a less than adequate standard format for someone else to employ in creating such material.

3. RECOMMENDATIONS TO ECSS

The working group on brochures in 1981 recognized the long standing problem and concern for a more efficient and effective soil survey program in the area of improved non-agronomic interpretations and land evaluations, and unanimously recommended that CDA increase the staff of the Land Resource Research Institute for the purpose of conducting an increased level of correlation and land evaluation research to improve guidelines for more effective interpretation and land evaluation of survey information for non-agronomic purposes. It especially drew attention to the need for such sustained research in the areas of a) Boreal Forest Region inventory, mapping methods required, correlation and interpretations; b) the application of survey information to the evaluation of wildlife habitat; c) an increased effort in developing guidelines for the application of soil survey information to a wide range of land use planning concerns from urban development to watershed management and environmental impact studies.

Since the 1981 meeting, little or no effort by the ECSS has been made to develop a suitable action plan to attempt to implement such a recommendation. The working group, therefore, strongly recommends that intent of the 1981 recommendations be included in any adjustment to "The Strategy for Land Resource Research in Canada" currently being considered by the Chairman of the ECSS.

ACKNOWLEDGEMENTS

The Chairman of the Working Group on Non-Agronomic Interpretations gratefully acknowledges the contribution to all who participated in the workshop discussion and in particular to those who assisted in the preparation of this report: R.H. Louie, G. Greenlee, G. Coen, C. Acton, K. Jones, J.M. Cossette, D. Holmstrom, J.H. Day, K. Webb, J. MacDougall, T. Macyk, G. Padbury, L. Van Vliet, D. Moon, G. Pierpoint, W. Michalyna, M. Langman, T. Vold, T. McKinnon, and H.W. Rees.

SOIL CLASSIFICATION

Charles Tarnocai

INTRODUCTION

During the ECSS meeting held in March, 1981, the following recommendations relating to the future activities of the Soil Classification Working Group were made:

1. Begin research work on Gleysolic soils.
2. Carry out the work relating to the classification of Folisols, organic horizons and humus forms.
3. Formulate definitions for diagnostic horizons for discussion.
4. Review the problems relating to the classification of Podzolic soils as submitted by the B.C. pedology group and formulate solutions to these problems.
5. Begin a two-year test on the definition of contrasting horizons and layers proposed by this working group.
6. Reactivate the Landform Classification Working Group.

ACTIVITIES IN 1981

1. Gleysolic Soils

Comments on the classification of Gleysols and gleyed subgroups were received from almost all regions of Canada (Tarnocai 1981). Since this is such a widespread problem, the Soil Classification Working Group decided that the problems relating to the classification of Gleysols and gleyed subgroups should be a high priority item in the future work on soil classification. The Soil Classification Section of the Land Resource Research Institute agreed to initiate a research project on Gleysolic soils. This project is being carried out by Alex McKeague and Chang Wang.

The work on Gleysols began and two field trips were organized for the summer of 1981, one in Manitoba and Saskatchewan and the other in British Columbia.

Some of the problems noted by McKeague (1981) during the Manitoba and Saskatchewan trip are as follows:

a. Soils with a chernozemic A horizon are underlain at a depth of approximately 25 cm by a horizon which has a gray (5Y 4/1) colour and is enriched in secondary carbonates. The low chroma may be due, however, to the colour of the secondary carbonates and not to reduction.

b. Prominently mottled sandy soils situated on slopes show a matrix chroma of 2 to 3 at depths below that of the Ah horizon. Insisting on a matrix chroma of 2 or less accompanied by prominent mottles would exclude this soil from the Gleysolic order.

c. Clayey, Red River and Osborne soils have chromas of 1 to 2 with some barely-visible rusty mottles below the black Ap horizon.

d. Rusty mottles indicative of gleying appear in soils that otherwise seem to be "well drained".

The field trip in British Columbia covered the Lower Fraser Valley, Vancouver Island and Saltspring Island (see memo Dec. 14, 1981, Summary of the B.C. Soil Classification Correlation Tour). Those who participated in this field trip felt that two basically different conditions occur in wet soils: (1) reduced conditions indicated by matrix colours of low chroma (generally 1 or less) which are usually associated with stagnant water; and (2) mottled conditions which result from alternating reducing and oxidizing conditions and are associated with a fluctuating water table, periodic perched water table or prolonged saturation during long periods of high rainfall.

The following criteria were tested during the tour and found to be workable for Gleysolic soils and gleyed subgroups of other orders in B.C. These criteria have already been used, to a limited extent, for classifying these soils in the Langley-Vancouver Soil Map Area (Luttmerding 1980).

Gleysolic - Gleysolic soils have features indicative of prolonged saturation with water which results in the development of reducing conditions. These soils have matrix colours of low chroma (1 or less) within 50 cm of the mineral surface. The horizons of these soils are associated with the suffix "g" (e.g. Bg, Cg).

Gleyed Subgroups - The gleyed subgroups of other orders have features indicating fluctuating water table or reducing conditions below the 50 cm depth. The fluctuating water table results primarily in the development of mottles. The horizons associated with these mottles are indicated by adding the suffix "gj". After examination of soils during the tour, the following criteria were developed:

Gleyed subgroups have distinct or prominent mottles above the 50 cm depth but do not display reduced (gray) colours (chroma 1 or less). The mottled layer must be greater than 10 cm thick and the upper half of this layer must be above the 50 cm depth. If mottling occurs in alternate layers, the total thickness must be greater than 10 cm and at least half of this should occur above the 50 cm depth. These soils may or may not have reduced horizons within the control section. If reduced horizons occur, these must be below the 50 cm depth.

Pedons from both Gleysolic soils and gleyed subgroups were collected by the Kelowna soil survey group and samples collected in Manitoba were submitted to the Soil Classification Section of the Land Resource Research Institute for analysis. These samples provide some of the data needed to study the properties of Gleysols and gleyed subgroups.

Recently, Alex McKeague (1982) has reviewed both the development of the classification of Gleysolic soils in Canada and the research relating to the development of specific criteria for soils of the Gleysolic order and gleyed subgroups. In this paper (McKeague 1982) the workplan for 1982 is discussed.

2. Classification of Folisols, Humus Forms and Organic Horizons

The problems concerning the classification of Folisols were introduced during the 1980 ECSS meeting (Trowbridge 1980) by the British Columbia Working Group on Organic Horizons, Folisols and Humus Form Classification. Since then this working group has submitted a further progress report on this subject (Trowbridge 1981).

During the 1981 British Columbia correlation tour it was unanimously agreed that Folisolic soils should be separated from the Organic order and the establishment of a Folisolic order was strongly favoured. A similar recommendation was made by the B.C. Working Group on Organic Horizons, Folisols and Humus Form Classification during the meeting held in April, 1982 in Victoria. The recommendations made by this working group will be reviewed by the Soil Classification Working Group and a final proposal will be presented to the ECSS.

The humus form classification has now been published (Klinka et al. 1981). This classification system is based on earlier systems but includes recent field experience obtained as a result of the Ecological Classification Program in British Columbia. The classification is based on the morphology and properties of the humus material.

Work has been carried out by Lowe (unpublished report) on the chemical properties and classification of organic horizons in British Columbia. The evaluation was based on 265 samples representing all major horizon types to be found in three regions of B.C. A stepwise discriminant analysis, based on thirteen variables, correctly predicted the horizon types (L, F, H, Of, Om and Oh) in 72.8% of the cases. Discrimination analysis for upland humus (L, F and H) and for peat horizons (Of, Om and Oh) led to a substantially greater predictive success, with 84.0% and 78.3% correct predictions, respectively. When discrimination analysis was applied to the separation of upland humus from peat horizons, the success rate was 93.6%. A number of other statistical analyses were also carried out and some additional chemical analyses were suggested in order to better characterize the organic horizons.

3. Definitions for Diagnostic Horizons

The concept of diagnostic horizons is not included in the Canadian System of Soil Classification although for Chernozemic soils the Chernozemic A is defined as a diagnostic horizon. It would probably simplify the soil classification if diagnostic horizons were defined for all orders since these horizons combine, in a single term, thickness with chemical and physical attributes. Alex McKeague and myself have begun to formulate tentative definitions of diagnostic horizons.

4. Problems Relating to the Classification of Podzolic Soils.

Some of these problems were identified during the 1981 B.C. Soil Classification Correlation Tour and, where possible, solutions were suggested. Those problems discussed in B.C. are as follows:

a. Subsurface organic layers or organic inclusions commonly occur in the B horizon of the coastal podzols. This organic material is mainly illuvial in origin although some in situ decomposed roots are present. Illuvial organic material commonly occurs in the lower part of the B horizon. It also very commonly forms a continuous layer on top of the duric horizon. The chemical composition of this organic material is different from that of the organic material in the upper part of the B horizon (L.E. Lowe, personal communication). Soils with these subsurface horizons are associated with higher forest productivity than are soils without it. Therefore, it was suggested by the participants that soils having subsurface organic horizons which occupy greater than 10% of the mineral portion of the pedon surface should be classified as an Organo subgroup of a Podzol (e.g. Organo Duric Ferro-Humic Podzol). It was also suggested that this subsurface organic "H" horizon should be identified by a suffix which would separate it from a surface H horizon. The suffix "h" for humified was suggested (e.g. Hh).

b. The proposal for setting up a diagnostic podzolic horizon as suggested by A. McKeague and C. Wang was well received. The diagnostic criterion for the podzolic B horizon is that the upper 10 cm of the B horizon must be a Bhf or Bf horizon if an Ae horizon is present. If the soil has no Ae horizon or if it is turbated, the 10 cm Bhf or Bf horizon must occur in the upper half of the deep podzolic B horizon or it may occur anywhere in the case of a shallow (less than 20 cm) B horizon.

c. There was some discussion on the problems relating to high elevation soils with dark coloured surface mineral horizons - those considered to have Sombric Ah's. All of these Ah horizons also meet the criteria for Bhf horizons and have pH values of 4.5 or less, high cation exchange capacities and very low base saturation. It was suggested that this dark coloured surface horizon should be called Bhf or that the ratio of humic to fulvic fractions suggested by Bersma and Lavkulich (Can. J. Soil Sci. 60:747-755) should be tried. To determine the horizon differences, a ratio of 100 or more was suggested for Ah horizons and less than 100 for B horizons.

d. It was suggested that soils which exhibit poor podzolic morphology but which have high sodium pyrophosphate-extractable Fe and Al also be defined according to the colour criteria and not only according to the extractable Fe and Al. Therefore, both colour and sodium pyrophosphate-extractable Fe and Al criteria are required equally for the classification of Podzols.

5. Definition of Contrasting Horizons and Layers

The two-year testing period on the definition of contrasting horizons and layers proposed by the Soil Classification Working Group will be completed this year. A final proposal will be submitted to the ECSS for acceptance.

6. The Landform Classification Working Group

A number of requests relating to landform classification have been channeled to the Soil Classification Working Group. In 1981 this working group recommended to the ECSS that the Landform Classification Working Group be reactivated to update the landform classification.

ACTIVITIES IN 1982

The Soil Classification Working Group's activities this year will follow the recommendations submitted to the ECSS on March 4, 1981 (Tarnocai 1981). The main activities in 1982 will be focussed on work relating to the classification of Gleysols, the formulation of a proposal for the classification of Folisols, and the definition of contrasting horizons.

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SOIL CLIMATE

G.F. Mills

Introduction

The Soil Climate Working Group was established in 1981 in response to a recommendation to the 1980 meeting of the Expert Committee on Soil Survey (ECSS). Based on provincial recommendations at the 1981 ECSS meeting (Annual Report of ECSS 1980-81), internal research priority for soil survey is to concentrate on three activities, one of which is soil climate.

The current meeting of the Soil Climate Working Group included representation from all Provinces and the Northwest Territories, which with other interested participants contributed to a very good discussion and a generally constructive session. The following report summarizes progress of the Working Group to date and detail plans for the short term priorities. The long term objective and priorities established at the Working Group meeting in 1981 are briefly reviewed (ECSS 1981).

Regional Reports

Regional reports were received dealing with Working Group activities during the past year and the current status of the soil climate monitoring network in each region.

The Atmospheric Environment Service (AES) of Environment Canada is collecting soil temperature data at 63 sites across Canada (Phillips and Aston, 1979). The distribution of these sites varies regionally across Canada and is summarized as of 1978 in Table 1.

In recent years, various soil survey units across Canada have become involved with research and monitoring activities designed to characterize soil thermal regimes. Monitoring activities outside of the AES program are continuing at various levels in most parts of Canada. New sites have been established within the past year in British Columbia, Alberta, Saskatchewan, Manitoba and Nova Scotia. The extent of the soil temperature monitoring network in various regions of Canada is summarized in Table 1.

In addition, specific research projects have been conducted by various soil science departments at Canadian universities. In British Columbia, soil temperature and soil moisture relations are being evaluated in term of forest growth. Studies in Alberta have characterized soil moisture and temperature properties related to specific genetic soil subgroups. In Saskatchewan, soil climate measurements are taken throughout the growing season at several sites under native grass, crop and fallow.

Table 1. Distribution of Soil Temperature Monitoring Sites in Canada[1].

REGION/affiliation	Duration of record, years						Total sites
	1	2-4	5-7	8-10	<10	>10	
BRITISH COLUMBIA							
AES					1	3	4
Ministry of Forests		58					62
		4*					
University of B.C.	2*	6					8
Ministry of Environment			22				22
REGIONAL TOTAL							96
YUKON and NORTHWEST TERRITORIES							
AES					3	4	7
Soil Survey	10*	8					18
REGIONAL TOTAL							25
ALBERTA							
AES					3	8	11
Soil Survey		33					33
Can. Forest Service	1						1
University of Alta.						1	1
REGIONAL TOTAL							46
SASKATCHEWAN							
AES					5	9	14
Soil Survey[2]		1					1
University of Sask.		2*					2
IBP (Matador)		1					1
Farm Lab	8						8
REGIONAL TOTAL							26
MANITOBA							
AES					2	2	4
Soil Survey	14	29	12	2		20	77
University of Man.[3]		2					2
REGIONAL TOTAL							83
ONTARIO							
AES					4	6	10
Soil Survey	2	2					4
LRRI[4]	2						2
Can. Forest Service		6*		1*			7
REGIONAL TOTAL							23

REGION/affiliation sites	Duration of record, years 1	2-4	5-7	8-10	<10	>10	Total
QUEBEC							
AES					3	5	8
REGIONAL TOTAL							8
NEW BRUNSWICK							
AES	1					1	2
Soil Survey[5]		1					1
REGIONAL TOTAL							3
NOVA SCOTIA							
AES						2	2
Soil Survey	14						14
REGIONAL TOTAL							16
PRINCE EDWARD ISLAND							
AES						1	1
Dept. Agric. and Forestry[6]						6	6
REGIONAL TOTAL							7
NEWFOUNDLAND							
AES						2	2
REGIONAL TOTAL							2
NATIONAL TOTAL							335

1 AES, Atmospheric Environment Service records compiled to 1978 and derived mainly from daily operations.
Most soil temperature data other than AES records consist of observations recorded at intervals ranging from 1 to 4 weeks.
2 Saskatchewan Soil Survey site consists of 8 subsites.
3 University of Manitoba sites consist of 11 subsites.
4 Land Resource Research Institute sites consist of intensive monitoring for time periods of 1 season or 1 year.
5 New Brunswick soil Survey site consist of 4 subsites.
6 P.E.I. Dept. Agric. and Forestry data consist of continuous records at 5 and 15 cm depths.
* Growing season data only.

The newly established Farm Lab program will provide soil temperatures measured at 8 sites located in various parts of Saskatchewan. In southern Manitoba two detailed study sites have been established to monitor soil temperature and soil moisture relations over a range of soil conditions; one, a toposequence in hummocky moraine and the other a soil drainage sequence on sandy lacustrine sediments with a high watertable. Other studies have evaluated the effects of different tillage practices on soil temperature and moisture. The soil survey recently established a detail site to study soil moisture and soil temperature characteristics in areas of discontinuous permafrost in northern Manitoba. In Quebec, the Soils Department at Laval University has attempted to correlate soil temperatures obtained at different observation intervals with the means calculated from daily measurements at St. Augustin. They also propose to evaluate the possibility of translating the air temperature zones contained in a recently published Agroclimatology Atlas (Dubé et. al., 1982) into a first approximation of soil temperature zones for southern portions of Quebec.

Provisional Methodology

During the past year the Working Group compiled a "Provisional Methodology" of various approaches and techniques currently being used for monitoring soil temperature in Canada. The intent of this "Methodology" is to provide soil survey units with background information necessary for establishing and maintaining a soil temperature monitoring network as part of routine survey activities. The Working Group is undertaking a review of the first draft of this "Methodology" and will incorporate any necessary revisions for circulation for trial use by regional soil survey units.

Data Handling Concerns

The Soil Climate Working Group is currently involved in what is best termed the "data collection phase" of the soil temperature monitoring program. As such, increased attention should be paid to data handling procedures. It is important to avoid duplication of effort and it is essential to insure quality control of the soil temperature data collected as part of the national network. In this regard the Working Group is making two recommendations:

1) That the soil temperature monitoring program encourage uniform standards for data collection and uniform procedures for data input, storage, retrieval and analysis. Various methods of instrumentation should be documented.

2) That, as soon as possible the Canada Soil Information System (CanSIS) provide technical assistance for the data handling and manipulation requirements of the national soil climate monitoring network. Immediate data handling requirements are:

a) programming input to universalize softwear currently available for handling soil temperature data, and

b) to advise on suitable header information and input format to enable the tie-in of soil temperature data to corresponding benchmark site data contained in the Detail II soil file and projected vegetation files.

With regard to the foregoing recommendations, consideration should be given to the fact that some soil survey units only have access to computer facilities through CanSIS. In addition, the CanSIS Working Group has established a priority to maintain compatibility between local and national files.

Short Term Priorities

The following short term priorities were identified for the 1982-83 time period:

1) Compile a bibliography of literature relevant to soil temperature, particularly instrumentation, measurement, characterization, classification and interpretation. References for this bibliography are to be channeled through R. Trowbridge of the British Columbia Ministry of Forests.

2) For areas of Canada where longer term (in excess of five years) soil temperature data are available, the responsible regional representative on the Working Group should begin evaluation of the data in terms of:

   a) comparison of soil temperature data with closely relevant aerial climatic data, ie. establish soil temperature-air temperature relationships.

   b) testing guidelines contained in U.S. Soil Taxonomy for the estimation of soil temperature regimes from a minimum level of key measurements.

3) Document ways in which soil temperature data may be interpreted for various biological and engineering applications.

4) Summarize the extent of aerial coverage for soil temperature data in Canada and identify gaps in soil temperature characterization.

Long Term Priorities

The long term priority for the Working Group continues to be evaluation and study of soil temperature for the purpose of better defining its role in the System of Soil Classification for Canada. Coincident with this objective, is study of the role that soil temperature may serve for soil correlation, soil interpretations and land evaluation.

At the time that reasonable aerial coverage of longer term (minimum 5 years) soil temperature data is available, the Working Group proposes to investigate how best to relate this data to the Canadian System of Soil Classification. Where necessary, revisions to the Soil Climate Map of Canada and the class limits assigned to the Temperature Classes for this map would be proposed. During this phase of the soil climate program, the Working Group will have to tie in with the Soil Classification Working Group and the Soil Water Interest Group.

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Soil and Terrain Information Required by the Ministry of Forests

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As I was preparing what I was going to say today I reflected on what has happened to pedology in the past decade within the Ministry of Forests. It is not an overstatement to say there have been some dramatic changes with regards to awareness and use of soils and terrain information by operational staff. We still have a long way to go but, because I am an optimist I'm sure we are going to make the progress that needs to be made. It is my observation that the 60's and 70's were decades of preparation when staff in the Ministry were seriously introduced to how pedologists and surficial geologists could help them. Also, it was a time when pedologists and others really seriously began to ask the forestry community what they needed and tried to meet their needs.

It is because of this ground work that I look to significant gains during the 1980's. In this respect we can think of it as "our decade" when we consider our potential impact on forest management.

What I am going to present today comes from a variety of sources within the Ministry of Forests. This has included information from both pedologists and operational staff. Also, I do not intend to make the list exhaustive and will therefore leave out any discussion about much of the obvious.

I had previously discussed with Steve what he and Scott were going to present, so while there will be some overlap it should be minimal.

I will proceed by first bringing you briefly up to date on recent events in the province which have made the need for soil and terrain information more apparent than ever before. Then we will go through a simplified version of the forest cycle and identify needs along the way. I will use examples of recent soils work which you may be interested in and I will end by speaking about our need to better present our information to the user. I do not plan on going into a great deal of detail but I hope some of the thoughts will generate discussion at the end. I will mention the work of several people here today and I am sure they will be pleased to talk about their work if you want them to.

One of the things that has made a significant impact on the soil and terrain information required is the Ministry of Forests Act (1978). It has provided the bases for a fresh look at the Forest resource as much more than must trees. The Act can be simply divided into four areas which make up the Ministry's management system.

1. Resource Analysis,
2. Five Year Program,
3. Annual Budget, and
4. Annual Report

I will discuss briefly the Resource analysis which is most important to us here today. It has five components. It describes the forest and range inventory or assets of the province and identifies the non-productive and underproductive areas. Or in other words, we are told which of our assets are in poor condition, therefore we have a better opportunity to do something about them. Future trends are analysed, and demand and supply are forecast to assist government in planning and developing strategy. The Resource Analysis also assess the impact of public policy on the Ministry and our impact on government. The most relevant part of the analysis to us here today is the description of Ministry programs. From this the effect of completed programs or collective action is made known.

For example, the analysis has shown we will have a future shortage of wood in the province probably at the end of the century due to the structure of our present crop if we harvest at the present rate. One way to reduce te future impact is to reduce the present cut or production target. Other ways to reduce the shortfall is by better utilization of the material in a given stand over time and to maximize the productive capacity of the site through decimals such as fertilizers. While there are several options to increase wood yield, the critical thing the legislation has done for us is provide the government with an analysis which gives options for m aking decisions about Ministry goals. Once goals have been approved management can then, though the 5 Year program, very quickly identify what is required to meet the goals. Subsequently, information about basic resources has been in high demand, including soil and terrain information. This information is being used not only to increase yields but to better realize integrated management objectives from competing resource sectors. Theoretically, we have always needed this information but now there is a mechanism for establishing where and how much.

The forest cycle as I will use it here includes preharvest assessment, post harvest prescriptions and stand establishment and treatment. I will concentrate primarily on the silvicultural side of things as Steve and Scott have covered adequately, engineering and slope stability. However, I will add a few comments on these aspects of forestry.

Preharvest assessment is probably the most important step which will ensure that our long term goals in the Ministry will be met. Terrain information is required for planning. This includes layout of main road systems with the best examples coming from the Cariboo Forest Region. Terrain also dictates whether an area can be considered operable or not. Areas of excessively unstable terrain or otherwise inaccessible areas will be removed from the harvestable area.

Slope stability is a major consideration, especially in coastal areas at this stage of wood extraction. As a result of resource conflicts, the Carnation Creek study was initiated on the west coast of Vancouver Island under the leadership of the Federal Department of Fisheries and Oceans. The program is process oriented and is made up of several projects which look at the impact of harvesting on fish and fish habitat. Research has been conducted into the kinds of debris entering the stream. More recently our attention has focussed on the Queen Charlotte Islands. It is required that stability mapping be conducted and used as part of the planning process. To be more consistent a Provincial Slope stability classification is being evolved under the leadership of Jim Schwab from the Research section in the Prince Rupert Region.

I do not want to make light of this very serious problem. To give you some indication of how serious we consider it, the Ministry of Environment, the Federal Department of Fisheries and Oceans, and ourselves are spending up to half a million dollars a year on the Queen Charlotte Islands alone to help us better answer the questions.

All of our work requiring terrain information relies heavily on the Terrain Classification System of the Terrestrial Studies Branch, and our people contribute to revision of the system based on their experience. This ensures that the system neets our needs.

At the preharvest assessment stage soils and other ecosystem components become important for Silviculture. The Ministry of Forests is steadily converting to an ecosystemk approach to forest management. It is our position that to be successful, foresters must manage with a concept of the total ecosystem in mind. We will all agree that soils is a component of major importance, and its importance will increase as wel move towards second and third growth management. At the present time we rely heavily on indicator species to give the manager information about the site but inevitably forestry will gradually develop a closer affinity with agriculture.

Before we harvest we should know the kind of crop we want at the end of the next rotation. This will mean determining the species or species mix to be planted which in turn will affect the kind of harvesting and more specifically the kind of site treatment to be conducted. For example, we have to know the impact of slash burning on a site quality and species requirements before we can develop proper planting prescriptions. Once harvesting has taken place the site has to be reassessed because harvesting and site preparation does not always provide the desired results.

Harvesting, with its associated roads, impacts on the soils resource, in a variety of ways. Dick Smith from the Canadian Forest Service has done considerable work on soil disturbance. We now need to develop a better understanding of what disturbance means. We need to know what kind of disturbance is good. Then we have to know how much of a good thing we need. It is obvious some kinds are not good!

It is unfortunate, but in some areas of the province excessive disturbance is being caused by practices which are known have a high negative impact.

Soil degradation is a major concern of the Ministry, primarily because we do not know what we are losing. In the past we have been mainly aware about the impact of disturbance on the streams. Now managers are aware that soil degradation means delays in plantation establishment and will extend the length of rotation. Also we are becoming more concerned about the area taken out of production either temporarily or permanently by roads, landings and through mass wasting. Because roads are the major cause of sedimentation to streams we have to be very concerned about the way we harvest an area.

Regardless of how careful we are there is always the potential for sediment to reach the stream. Therefore, we have thought it important to study methods of stream rehabilitation as part of our Queen Charlotte Islands program.

Research conducted by Bill Carr and Stephen Homoky has been aimed at roadside stabilization through the use of hydroseeding. Equipment has been developed which doubles as firefighting equipment. This makes it a much more practical solution to the problem than previously. However, control of mass wasting once it has occurred remains a problem, as in most cases it is extremely costly to control.

The humus layers, that long neglected part of the solum has to be given careful attention if we are to meet our silvicultural objectives. As our pedologists worked with operational foresters it was constantly brought home that humus forms influenced many decisions. However, it was concluded that we required a more comprehensive system of calssification if we were to be able to describe, identify and understand the humus form that we were managing - hence the development of the Taxonomic Classification of Humus Forms in Ecosystems of British Columbia by Karl Klinka, Bob Green, Rick Trowbridge and Lawrence Lowe.

I would suggest that the classification represents a greater need in forestry and will lead, through considerable research, to a better understanding of the role humus plays in the productivity of our forests. Prior to this undertaking we have to test the classification to ensure as well as possible that the taxonomic units are meaningful in the field.

Once we have prepared a site for planting or natural regeneration we are concerned about stand establishment. Planting failures continue to plague forestry, especially in the interior of the Province. An average survival of 50% for plantations in this drier region is not uncommon. In some cases enture plantations are lost. Several years of research have not provided the answer. It is true that seeding quality at time of planting and the quality of planting are compounding factors. However, there is every reason to believe that we have to know a great deal more about soil climate and its effect on seedlings before we can develop meaningful planting guidelines. This is our most pressing need for soil climate information at the present time but as our wood resource becomes more valuable and the capital expended to increase yield is increased we have to know the relationship between soil moisture and temperature and stand productivity.

For example, Andy Black and Dave Spittlehouse at U.B.C. have been developing a water balance model for a forested stand on Vancouver Island. One of their study sites is located in a widely spaced stand of second growth Douglas-fir.

As part of the study the water used by both the understody vegetation (predominately, salal) and the trees has beene measured. Over the period of water deficit the understory vegetation used approximately the same amount of water as the trees. The obviouis implications to management are that while one may intend to maximize growth through planting or thinning to obtain a widely spaced stand, the manager should in this situation be creating a stand which will eliminate the competition and make as much water available to the crop as possible. While the previous example was related to soil water the same should be done for soil nutrients. We should know how understory vegetation relates to humus form and how this in turn affects tree growth. We need to develop better indicies of nutrient availability, especially for nitrogen.

This logically leads to another deficiency in soils information for forestry use - that of soil analysis. While many of the analyses presently accepted for agriculture may be useful for forestry, much has to be done to calibrate results into meaningful interpretations. For example, Lawrence Lowe at U.B.C. has developed and tested a method for sulfur analysis which will be used for fertilization studies and subsequently operational work. Also, Jacob Octere Boateng and Tim Ballard are developing methods to determine available phosphorus in forest soils. As work continues in soil analysis and we have more confidence that the results are applicable to forestry, we will be able to increase the reliability of our interpretations. It will also clarify what analysis we are required to do.

Meaningful soil sampling methods also have to be developed for operational use. We all know the procedures that are used in agriculture for making fertilizer recommendations. No such system has been developed for forest soils. Should we continue to sample and treat our soils using pedogenic breaks or can we sample layers by depth? In some surveys bulk density is often missing therefore maiking it impossible to convert accurately to kg/ha. In other surveys we continue to use the philosophy that because we are out there we should measure everythingg we can. Hopefully we can progress rapidly to a more efficient and effective survey because of increased understanding of the resource.

As we apply various treatments to our plantations or natural stands we impact on the soil in many ways. Harvesting and stand treatments such as selective logging can cause adverse effects to the site. Studies have shown that the desired effects expected from thinning are now always realized due to compaction and subsequent aeration problems. Regardless of the method used to carry out the treatment we should know what the impact is on the soil.

More and more we are using increased amounts of chemicals in stand treatments including fertilizers, pesticides and herbicides. As an example of this increase we can look at forest fertilization. From 1963 to 1978 an average of 1000 ha per year were fertilized. In 1978 our Ministry and industry projects were just over 10,000 ha and last year 20,000 ha. of forest were fertilized. While we may not be concerned about the impact on the soil directly we are expected to know the fate of these materials as they may impact upon fish in adjacent streams.

Another concern related to streams is the impact of harvesting on flow regimes. For example, major concerns have been raised in the interior of the province where many people have considered harvesting to be the causes of reduced flows during dry periods. While several factors do play a role in this model, it is safe to say that the hydrologic properties after logging and any changes which occur over time are of interest not only to the water use but also the forester. Why are we concerned about water? If the public feels their water supply is in jeopardy the first thing we are faced with is a moratorium on logging. We have to know what is going on if we are to make rational resource decisions. We are also concerned about changes which impact on productivity.

What do we do with all the answers once we have them? Providing information about soil and terrain to Ministry staff without adequate training is often counter-productive. In this respect it is no different than information for other users and in any project the producer of the information should consider from the beginning how the material will be presented. We all know that it is important that anyone using soil and terrain information have a good understanding to avoid unfortunate failures which could have been avoided. This has been said many times before, but our experience shows it is necessary to repeat it often.

One of the methods we have used successfully in the Ministry both for management and as a training tool is the Edatopic Grid. The grid was first proposed by Progrebniac in 1929 so you can see it is not a modern invention.

At first glance the system looks so simple its value could be questioned. However, it has proven valuable because it makes a manager "think" and the probability of coming to the same conclusion as the "experts" is quite high.

When the manager goes into the field he has previously located himself within a broad prestratified unit on a map and selects the correct grid for that unit. On the ground he is then expected to locate this site on the grid from the soil moisture and soil nutrient regimes. These are both rather difficult parameters to identify in themselves and the person must make many observations before he comes to a conclusion. Slope position, tree growth, soil texture, presence of mottles, minor vegetation and humus form are all considered before soil moisture can be estimated. Soil nutrient regime is estimated by using the appropriate observations for soil moisture plus the type of parent material. Interpretations prepared by pedologists, ecologists and silviculturists such as species to be planted are then used when the position of the site has been identified on the grid.

Those of you who have worked with operational people in the bush know that many of them are good ecologists or pedologists. As you can see, while the grid is simple it essentially forces the managers to consider much more than they have in the past. It is a way of organizing and adding to their knowledge in a systematic fashion.

While the grid has been useful there are things that could be done to improve the use of this tool. First the parameters have to be quantified. The soil moisture regime has been studied for one area by Don Giles working at UBC. Now that techniques have been tested it would be useful to apply the system to other areas. Also, it is very likely the parameters could be effectively changed depending on regional conditions. For example, soil temperature regime may be considered more important in the north.

I have used the grid as an example of one way to present information. We are constantly looking for ideas.

While I have presented a long but by no means comprehensive list of needs by the ministry, we cannot expect to have soil and terrain information solve all of our problems. Prior to hiring our regional pedologists in 1974 I travelled to all six Forest Regions to find out what preconceptions the regions had about pedologists and what kinds of problems they would, or could become involved in. The response was varied. It ranged from not really needing a pedologist, especially in research, to feeling that the pedologist could solve all their problems. Neither response is of course true. I have found over the past several years that it is important we do not make claims about soil and terrain information that are not realistic. We have to be especially careful because most of us have been trained in Faculties of Agriculture. I use forest fertilization as an example. I mentioned before that we required sampling methods which are as meaningful as those which have been developed in agriculture. To do this we must first establish the relationship between soil nutrient status and growth response.

At the present time Tim Ballard of UBC has found that foliar analysis is more useful for making fertilizer prescriptions than soils information. Whether the reason is the kind of crop we are growing or simply that we do not know what soils information to collect or how to analyse it is irrelevant to operational staff. We have to be willing to give up some of our traditional concepts if they do not functiuon operationally.

The research and operational activities we are presently supporting in the Ministry are some of the things which we feel we are required to know. I have reviewed some of the work that we are doing or are having done for us, primarily by students and researchers at UBC. Many other agencies including the Canadian Forestry Service, Agriculture Canada and the forest industry will continue to supply answers to high priority questions.

The Ministry of Forests also has the responsibility for Crown range lands in the Province. The soil and terrain information we need are similar for range and forestry even though the magnitude of the process may vary.

One of the most important things we need to know about is range condition. Without it a range manager cannot do his job. Without soils information, good range condition guides will not be developed.

I use fire to represent all the impacts that management can have on a site.

I would like to make one comment about our responsibilities as professionals. The list of required soil and terrain information is long but it is up to us to be sure we have differentiated between what users want and what they need. Too often pedologists spend considerable time providing information which will not have an impact on management decisions. The user finds the information nice to have. It is up to us to work with the users of our information to ensure efficiency and effectiveness.

A recent Masters thesis titled "A Method for Producing (Soil - Vegetative Landform) Maps With Users Involvement" by Ed Pottinger has attempted to find out, by more rigourous methods than are usually used, what the users need. The study was based on a questionaire-interview program and tested the usefulness of user input into map and information retrieval systems. The study was of particular interest to us because the samples used were taken from a forested watershed here on the coast. You may be interested in reading the thesis.

The conclusion of the thesis reads -

In conclusion, the method works and should be incorporated in future inventories (future recommendations are included). It is an inexpensive and relatively simple procedure with which to test possible inventory, mapping and presentation techniques. The fact that this study indicated a significant difference between the desires and/or requirements of the map producers and the map users suggests a technique of this sort is certainly a necessity. It should also act as a very good user-producer relations and education tool. Introducing the maps to the potential users and having them involved in their design should improve information flow.

An example of these differences of opinion was map scale. Maps at scales of 1:20,000 or larger were those identified as being most required in the study.

Scale was identified as a concern this morning. For the last few years we have requested operational staff to identify their soil and terrain survey needs. We have been getting the same message about scale, especially for critical areas. While 1:50,000 maps may serve as a planning tool, areas to be harvested are primarily identified by the kind and quality of trees present, a disease outbreak or some other cause. An area is considered critical if there are potential resource conflicts or unusual biophysical characteristics. The Terrestrial Studies Branch and our Ministry have struck up a committee to try to develop a feasible solution.

I was fortunate enough to be at UBC in the early 70's when Dr. Kubrina visited the university. Even though he was over 75 years of age he collected samples for thin sections to continue his research. In spite of the fact the samples were collected in a shaky manner we were all impressed. Dr. Kubrina was also enthusiastic about our forests and our soils in British Columbia. If we who are working in soils and terrain developed the same enthusiasm as this old gentleman had and we met 10 years from now to discuss the use of soil and terrain information by forestry we should have a very progressive story to tell.

SOIL INTERPRETATION FOR FORESTRY
WORKING GROUP REPORT 1981/82

H.H. Krause

The working group conducted a half-day meeting which was attended by approximately 50 persons and which aimed to review existing approaches to soil interpretation for forestry and to define, tentatively, improved guidelines for future use in Canada. Attention was given to productivity, the suitability of species, limitations to various management related activities, and environmental hazards as principal criteria for forestry interpretations. The following is based on contributions from the various speakers, the ensuing discussions or it represents my own commentary.

Productivity. To provide an objective base for land evaluation and land use planning was seen as the main reason for a rating of soils with respect to forest productivity in survey reports. The information provided by the Canada Land Inventory one decade ago is inaccurate and in need of improvement. Little research has been conducted in Canada to deduce forest productivity from soil and environmental factors. Use of data from permanent sample plots and measurements on existing forest stands must remain, therefore, the general approach to rating and grouping of soils with respect to productivity until some time in the future.

Forest management decisions are based on forest inventories which are carried out on a stand-by-stand basis and are more accurate than information that could be obtained from a small-scale (1:50,000 or smaller) soil map. However present forests in many parts of Canada underutilize the given potential of soils because of lack of management and overharvesting. A realistic productivity rating in connection with large-scale soil surveys would also benefit, therefore, various phases of forestry planning, and aid special projects of site classification and mapping.

Species suitability. It was suggested that survey reports list, for each mapping or taxonomic unit, the dominant species of the associated natural forest, as been the practice in several provinces for some time. This would fulfill a double purpose: A record is produced of the natural vegetation associated with a given soil and, since it has been a common approach to regenerate a forest to the same species it contained previously, a basis for species selection is given.

This simple approach to species selection presumably will go through various stages of development as new information becomes available. An important factor is that species occurring naturally on the same site usually exhibit varying degrees of productivity and differ in their response to management. The interaction of soil and species response to management is specialized information and known to few, if at all today. Advances in this area and due consideration to stand stability and economic values are likely to become the key components of future guidelines for species selection.

Limitations to forest regeneration. Tree seedling development and the growth of planted trees are frequently limited by low soil temperatures, moisture stress and/or lack of nutrients. Other factors often of importance are poor aeration, susceptibility to frost action and competition from other plants. Pertinent soil information is available from survey reports and predictions regarding forest regeneration could be made routinely where soil surveys have been conducted, provided that the interrelationships between soil parameters and seedling development or plantation growth are sufficiently known. Obviously, these interrelationships are better understood, today, for some species than for others, and better known in some areas than in others. The development of reliable and generally applicable guidelines must depend, therefore, on the rate at which biological information becomes available. Such guidelines, to be complete, must also include information on the requirements for site preparation.

Limitations to logging road construction and off-road transportation. Guidelines based on common terrain and soil characteristics and following closely earlier proposals (T.Vold, 1981. Discussion paper: Soil interpretation for forestry B.C. Ministry of Environment) were presented to the group. These guidelines, not being complicated by complex interactions of biological systems and physical environment, did not present any particular problem and were given provisional approval by the Working Group.

Erosion and mass movement hazards. Suggestions were made for assessing the potential of soils to yield sediment and for evaluating their susceptibility to mass movement. Since these suggestions were based on experience gained entirely in coastal British Columbia, the author (D. Moon) doubted their applicability to other parts of the country, even other parts of the same province. The definition of generally applicable guidelines for the rating of soils with respect to erosion and mass movement hazards requires, therefore, additional input from other provinces.

Windthrow, frost action and flooding hazards. Given certain meteorological conditions, forest type and set of management practices, physiographic and edaphic factors, as normally recorded in soil surveys, are important variables in windthrow hazard ratings. A guide for determining degrees of limitation due to windthrow hazard was proposed and provisionally approved by the Working Group.

Frost action in soil heaves tree seedlings out of the ground and damages roads. The frequency of occurrence and severity varies with climate (latitude and altitude) and, within certain climatic limits, with edaphic factors, predominantly texture and moisture content. Guidelines based on these variables were proposed to the Group.

Although the flooding hazard does not appear to be as important to forestry as to other forms of land use, it presents a limitation to certain operations and should therefore be a part of soil interpretations for forestry. While identifying affected soils, important criteria appear to be frequency and duration of flooding.

The active membership of the Working Group and the areas of contribution from individual members are as follows: D.J. Pluth, University of Alberta and V.R. Timmer, University of Toronto (soil productivity); J.K. Jeglum, Can. For. Serv., R.K. Jones and H. Veldhuis, Agric. Canada (species suitability); T. Ballard, University of British Columbia (limitations to forest regeneration); H. Rees, Agric. Canada (limitations to off-road transportation); K.T. Webb, Agric. Canada (limitations to logging road construction); D. Moon, Agric. Canada (erosion and mass movement hazards); W. Holland, Can. For. Serv. (windthrow, frost action and flooding hazards); T. Vold, B.C. Ministry Env. (Secretary).

The Working Group's plan for 1982/83 includes further research of existing information and refinement of provisional guidelines for presentation to the Expert Committee at the earliest possible time.

The Use and Needs of Soil and Terrain Survey Information in the B.C. Forest Industry

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The use of soil and terrain survey information by the B.C. Forest Industry varies considerably from company to company. The type of land tenure under which the company operates, the size of the company, the type of terrain it operates in, and the potential for conflict with other resources, are all factors in determining an individual company's interest in soil data.

Land Tenure

Forest companies in B.C. operate under various types of tenure which is reflected in the different levels of land management. Some of the larger companies have title to large tracts of land. The majority of their tenures however, especially on the coast, are in the form of Tree Farm Licences. This is a long term lease to the company, who in return must manage the land, being responsible for all road building, harvesting, slash-burning, planting, silviculture, and providing recreational facilities. The degree of management is similar to what would be done on privately owned land. An important difference however, is that all development plans are subject to scrutiny and approval by government regulatory agencies, such as the Forest Service, the Provincial Fish and Wildlife branch and Federal Fisheries. The majority of the coast is taken up in TFLs, given out to the larger companies.

Timber licences, by contrast, are areas where a company has only cutting rights. Following harvesting, the land reverts to the Crown, with the Forest Service responsible. The interior of B.C. is predominately in timber licences and temporary tenure agreements, where most of the smaller companies do their logging. There are other types of tenure, but there is no point in detailing them. The point is that because of the different types of tenure, there is a different level of land stewardship and hence a different level of use and interest in soil survey information.

Uses of Soil and Terrain Information

In order of priority, the reasons a forest company wants soil information are because of potential resource conflicts, for road related uses, and lastly for silvicultural purposes.

1) Resource Conflicts

In B.C., many companies are operating in steep unstable land, carrying out harvesting operations that may conflict with other resources. In particular the fisheries resource. In fact, it is fair statement that the existence of the Fisheries Act is the single main reason why forest companies on the coast have soil or terrain surveys done.

Much of the easily accessable, valley bottom land in coastal B.C. has already been harvested. Increasingly, clearcutting activity is taking place on steep, often unstable slopes. More often than not, the streams draining these valleys are highly productive anadromous fish waters. Activities associated with logging, in particular road building, can significantly decrease the stability of a slope.

Identification of these potentially unstable zones is desirable from a number of viewpoints:

- Cutting permit approvals (reviewed by Fisheries agencies) are contingent on avoidance of areas that may cause an impact on the fish stream.
- A sincere desire on the part of forest companies not to pollute fish streams or water supplies.
- The high cost of roads, currently averaging over $100,000/mile, creates a desire to minimize losses to slides.
- Forest site loss. There has been at least one instance where a forest company lost 10% of its harvestable wood to road induced landslides prior to beginning cutting. Slide scars also definitely have longer rotation ages than stable slopes. As timber short falls become more apparent in the years to come, site loss will become increasingly important, however to date it has not been considered a major concern by the companies or the Forest Service.

Because of these reasons, the major activity of the forest pedologist is the preparation of derivative slope stability maps. The system currently in use by MB, and similar to versions used by other companies, is a 5 class stability system, rating the land from stable to unstable. These maps are prepared from terrain mapping, done by the company pedologist. The mapping system used is the ELUC Terrain Classification System (1978), with modifications to include extra notation for geomorphic processes, the inclusion of soil moisture regime classes, and a different slope angle classification. Most data collected for flat land agricultural soil surveys are irrelevant to the stability problem; the emphasis must be on terrain and processes.

It is emphasized that these stability maps are not maps derived strictly from terrain maps. Rather, they are interpretive maps in which the terrain map is an aid. Knowing that a stability map is the desired end product definitely influences polygon boundary location during field mapping.

2. Road-Related Uses

A road engineer has a number of concerns when selecting a road route. Grade is the most important consideration. Second is the location of bridges and third is the volume of timber along the right-of-way. Only after these considerations are met, will the engineer start looking at soils information.

Soil and terrain survey information can be useful for delineation of favorable road routes as well as the selection of native materials for road ballasting. In the past, roads have often been built irrespective of soil types. The different bearing capacities of the soils have been accomodated by just dumping on more ballast.

As road costs have soared in recent years, this practice is beginning to fade. Ballast costs alone can account for half of the road cost and in some cases has run over $75,000? mile. On the Queen Charlotte Islands, ballasting requirements range from 100 to 400 m^3/100 ft. road, depending on the terrain type.

A parallel tactic being used by road engineers to reduce costs is to use native materials instead of crushed rock or gravel for the ballast. In many areas sandy till makes excellent, free draining ballast.

Both the use of native materials and the use of soils with greater bearing capacities as subgrade requires very careful route locations, and requires very detailed soils maps along probable access corridors. The important soil parameters are soil void ratio, moisture regime, and precise textural description. However, in most cases it is not necessary to go to even that level of sophistication. We suggest that merely mapping the materials and moisture regime at a 1:5,000 scale and then preparing a 4 class interpretive map would be very effective in reducing ballast costs.

3. Site Loss

Forest site loss due to landslides has been discussed above. A related problem is the deterioration of forest site due to soil compaction. This mainly occurs during skidder logging, a practice more common in the B.C. interior. All soils are susceptible to compaction, however, those with a low initial bulk density are the most problematic.

Unfortunately, this parameter is rarely included in survey reports. While inferences can be made from textural data, the variability in texture-compaction relationships are too great to be useful. Soil bulk density is an easily measured parameter and should, in potential skidder logging areas, be part of a soil survey.

4. Silvicultural Uses

At the present time, while soils data is used by a forester, there is very little need for soil or terrain survey information by the company foresters. Virtually all soils information that is relevant to silviculture is best collected on site, rather than interpreted from a map or survey report.

A forest engineer, has a great deal of latitude in the placement of his roads and cutblocks, especially when entering a new watershed. It is a great advantage to have a map in front of him showing all the forest types and relative slope stabilities.

The forester, by contrast, is locked into a cutblock. He has no choice when he plants his trees; they have to go where the loggers cut them down. On average, a divisional forester will look at about 10 new openings a year, providing plenty of time to thoroughly investigate each site, both before and after harvesting. He therefore, gathers much more detailed and accurate information than is possible from a routine soil survey.

Soil survey information that would be useful to the forester is interpretive results, giving him information that he is unable to evaluate on his own. Such interpretations as the susceptibility of the soil to frost heave (often quite a problem in north facing slopes), the potential for seedling mortality due to excessive soil temperatures in clearcuts, or the potential for excessive drying during drought.

Soil productivity relationships may be of benefit in providing a measure of tree performance, indicating whether a stand is producing up to its potential. As a means of predicting forest yield however, such relationships would be of limited use in coastal B.C. MacMillan Bloedel, for example, has had all of their land timber cruised: each stand has a site index, obtained from direct measurement of the trees. There is little reason to rely on derived, empirical relationships between soil type and tree growth.

More research on growth response following various treatments on different soil types would be very beneficial. Treatment response information on disturbances to the forest floor should be particularly interesting. After all, it is the forest floor that is the most important layer nutritionally and it is also the forest floor that suffers the greatest disturbance during harvesting and slashburning.

Treatment response data in conjunction with a soil series map would be very useful in forest fertilization. A soils map alone however, may tell you where not to fertilize (rock outcrops), but provides no information about where, or how much, or what kind of fertilizer is needed on the various soils. In spite of much talk of intensive forest practices, very little fertilization is in fact being carried out today in B.C. Where it is, little attention is being paid to soils; the fertilizer is just spread uniformly over a broad area or else concentrated on high site index areas. We would appear to be a number of years from this type of fertilizer-response information in B.C., and there is little hope in waiting for industry to do it, because absolutely no research of this type is being carried out by any forest company in B.C.

Present Use of Government Soil or Terrain Reports

In order to gauge the use of government soil maps and reports, we conducted a poll of most of the forest companys in B.C. We found little to no use by industry of any government soils or terrain maps in the majority of forest operations in B.C. If there is use, it is at the planning level; operationally there is essentially none. The exceptions to this situation are some of the larger companies, who have either their own company pedologists or use outside soils consultants. Again, however, very little use is made of government mapping. The reasons for this lack of use are:

1. The scale of government maps is nearly always inappropriate. Nearly all forest management (engineering, road layout, cutting blocks) is done at a 1:20,000 scale. Final cutting permits are done at 1:5,000. Most government maps are at 1:50,000 to 1:250,000 scale. When timber deferrals are at stake, this low level of detail on small scale maps is unacceptable. Where time or budget constraints preclude detail mapping of an entire watershed, then a combination of detail and reconnaissance mapping has been used successfully on the same mapsheet. For engineering purposes, the two zones of main concern are the steep hillslopes, where there are stability concerns and secondly the valley bottoms where mainline roads are located. It is much more useful to produce highly detailed and accurate units in these areas and larger more general units in the rest of the watershed, where we have little to recommend.

2. Often standard "multi-purpose" terrain or sail survey maps do not contain sufficient information to produce accurate derivative maps. For example, a recently completed multivariate analysis of terrain features associated with landslides on the Queen Charlotte Islands, indicates that proximity to gullys, drainage path length, soil moisture regime, slope angle, and soil depth are the most important factors for slope stability assessment. The former factors are never collected, the latter are sometimes collected, but usually in categories inappropriate for stability analysis. For instance, many soil inventories break slope classes at the lower gradients but have broad classes in the 30^{o} - 45^{o} range which is critical to slope stability.

   This type of problem is inherent to a survey that tries to cover all possible users. Many areas have only one or two likely users; the survey design should be custom made for that client.

3. Report Format. The presentation of soils information is extremely important as to whether a company forester or engineer will use the information. Our experinece is that information that is contained in a report, whether it be prose, tables or lists, rarely gets used. As much as possible,

soil information should be presented in map format. It should be at a scale that the forester can overlay his road map or forest cover map to see immediately what your interpretations are.

Interpretive maps are also the key. Few engineers or foresters have the inclination to use a terrain or soils data map. They want to know immediately how stable that hill is, or what the relative trafficability is. They are not interested in having to work their way through factor tables.

At MacMillan Bloedel, we now routinely produce two derivative maps used for engineering purposes, for every terrain map. One is the stability map, in which each terrain polygon is assigned a rating. The other, is a map in which the terrain polygons are grouped into associations based on their similar behaviour and response to road building. On average, each map has 8-10 terrain associations. The map legend includes a list of the implications of the terrain characteristics to road building, as well as a separate list of recommendations as to how they should handle these situations. This list of recommendations was drawn up in concert with a group of forest engineers and road foremen, and has proved quite successful.

4. Confusing map legends. While the problem of vastly different symbology between soils maps has been partially rectified in recent years, this remains one of the main complaints voiced by company foresters. The closed legend, or soil series type of map, was usually preferred to the open style legend.

   Again, nearly all respondents wanted legends that stress the behavior of the soil, with less emphasis on its description. The profusion of incomplete, "provisional" maps, has certainly contributed to this feeling of unease with soil or terrain maps.

5. Poor recommendations. Part of the success of in-house, or consulting pedologists is that they work closely with company engineers and foresters during the actual mapping as well as during the preparation of legends. The resultant recommendations are consequently relevant to the type of harvesting being carried out. Most companies complained of naive harvesting recommendations within government reports, often leading to distrust of the rest of the report.

Conclusions

The majority of the soil survey information being used by the forest industry in B.C. is coming from their own pedologists or consultants. Their surveys are more successful because they are single purpose surveys, prepared in close conjunction with the engineers and foresters, and done at a 1:20,000 scale, corresponding to forest cover maps and engineering maps. To be used the information should be in map form, not report format, and single subject interpretive maps prepared. On the coast the most desirable product is slope stability maps and then interpretive maps related to road building. Because of the no choice, site-specific nature of silviculture, soil survey data maps are not particularly useful. However, interpretive maps of soil behavior relevant to seedling survival would be useful. Treatment-response data is particularly needed, and when it is available, soil series maps will then be invaluable to the forester.

SOIL WATER REGIME CLASSIFICATION 1982

R.G. EILERS

INTRODUCTION

This report can be considered as the first progress report of Phase II of the Soil Water Interest Group (SWIG). Phase I consisted of the development of criteria for a more quantitative and comprehensive classification of soil water regimes. Phase II will consist of data acquisition and criteria evaluation to test the proposed soil water classification system.

At the culmination of Phase I SWIG made the following recommendations; (ECSS Proc. 1981).

1. SWIG recommends testing of proposed classification of soil water regime for a trial period of five years, subject to re-evaluation at that time.
2. SWIG recommends compilation of a Soil Water Investigations Methods Manual, to guide collection of data needed in the characterization of water regimes by soil survey. SWIG would assume the editorial role.

A number of miscellaneous recommendations were also made for the future attention of SWIG:

1. Top priority should be given to integrating Cryosolic soils into the Soil Water Classification Scheme.
2. Top priority should also be given to exploring ways and means of integrating soil survey efforts with that of other agencies to expend the SWABS network.
3. SWIG should investigate the need for introducing climatic parameters into the Classification System for Soil Water Regimes.
4. The operation of the proposed Classification Scheme, if adopted, should be monitored by Soil Survey Units and correlators, with a view to circulating periodically a summary review.

In response to these recommendations SWIG workers have embarked on a program of DRAFTS i.e. The "Development of Regional Activities for Testing SWIG." In recognition of the fact that a national classification system for soil water regimes must have a certain degree of regional flexibility nearly all soil survey units initiated some evaluation activity in this area. A brief and somewhat incomplete (with apologies) review of various SWIG-related activities across the country is given in table I.

Table I Additional SWIG activities in 1981 included a joint soil tour through southern Manitoba and south eastern Saskatchewan, participants from Ottawa, Manitoba, and Saskatchewan reviewed the criteria for classifying Gleyed and Gleysolic soils in the field. In addition to soil taxonomic concerns participants also attempted to use the SWIG criteria to define the drainage regime. The following example is a summary of the SWIG description for a site inspection by the tour participants.

Table 1. SUMMARY OF SWIG RELATED ACTIVITIES 1982.

PROVINCE	DESCRIPTION OF PROJECT	MONITORING
British Columbia	4 sites (x2 subsites) "Sub-irrigation potential from groundwater" (DYSTRIC BRUNISOLS) Numerous additional water table observation wells in active soil survey project areas	Water tables Soil moisture Bulk Density Evapotranspiration "K-sat"-Lab-Cores Soil water budget
Alberta	10 sites	Soil moisture Soil temperature
Saskatchewan	3 Toposequences Student thesis project (U of S) (Hummocky dark brown chernozemic soils)	Water tables-wells -piezometers Physical and Morphological soil properties
Manitoba	4 multi-purpose SWABS (all co-operative studies) a) Water regimes vs productivity in wet porous sands (ALMASIPPI Soils - U of M)	Water tables-wells -piezometers Water quality Soil temperature Soil moisture "K-sat" Lab-Field Bulk density Infiltration
	b) Hummocky glacial till (student thesis project U of M)	Air Temp and rainfall Physical and morphological soil properties.
	c) Drainage of clay soils (MDA - soil survey) d) Bog-veneer in discontinuous permafrost zone near Thompson (MDA - Soil Survey) Major soil types studies include black chernozems, regosols, gleysols and cryosols.	

PROVINCE	DESCRIPTION OF PROJECT	MONITORING
	In addition about 80 water table observation wells in detailed soil survey areas in southern Manitoba, are being monitored routinely.	
Ontario	32 sites (Grey Brown Luvisols)	Water Table Physical and morphological soil properties.
Ottawa	Development of criteria for estimating "K-sat" From soil texture and soil structure Development of TDR method of measuring soil water content. Numerous methods of measuring "K-sat" and infiltration (air entry permeameter, constant head permeameter, and auger hole method) under refinement.	Hydrologic properties of soils. Water table wells Precipitation Soil moisture
Quebec	Correlation of field measured "K-sat" data from drainage investigations to soil map units. Numerous water table observation wells in active soil survey projects	
New Brunswick	6 sites	Water table-wells
Nova Scotia	10 sites	Water table-wells Soil temperatures
P.E.I.	No activity	
Newfoundland	?	

The soil examined was identified as Reinland series, an imperfectly drained, moderately course textured lacustrine soil and classified as a Gleyed Rego Black, chernozemic.

Most of the participants classified the water regime of this soil according to the 1981 SWIG classification system as follows: A 150-199 mm moisture deficit, moderate to rapid (4.2 - 16.7 cm/hr). Hydraulic conductivity, average high water tables of 150-200 cm for 2 to 60 days during the growing season, average lowest water tables of 200-300 cm, neutral water quality, and modified by an adjacent road ditch.

The intention is to eventually have aridity values calculated for all soils rather than use estimates. The remainder of the SWIG description is more quantitative than the former drainage designation. The accuracy of the description is believed to be acceptable based on soil and water data for other analogous soils. Tests have shown that there is a high probability of estimating to within 1 class of the measure "K-Sat." class. I believe that in time we will become more at ease with this system and as we develop more definitive guidelines the accuracy of the "K-Sat." estimates will increase.

SWABS

The establishment of soil-water bench mark sites for testing the SWIG classification system has been recommended as the most desirable approach. Unfortunately, this is also the most expensive approach, both in terms of staff and equipment requirements. However, all data acquired through routine servicing and monitoring procedures have this same disadvantage. In Manitoba deliberate effort has been made to develop cooperative working arrangements with other agencies and government departments in the establishment and monitoring of detailed investigation sites. Some of these sites were established for purpose other than SWIG but because of the distribution and potential longevity (to 5 yrs) of these sites they have relevent potential for SWIG objectives.

Four SWABS have now been established in Manitoba. Two sites were established in 1981, while two were established previously.

Three of these sites were established as cooperative projects with other agencies and were designed with multipurpose use in mind. The fourth site was established in cooperation with the Soil Climate Working Group. The latter site is located near Thompson, Manitoba in an area of discontinuous permafrost. It is hoped that data collected at this date will be useful in developing SWIG criteria for northern Cryosolic soils.

1. Almasippi Wet Sands Management Project (AWSM) - (U of M & Soil Survey)

A deluxe soil water benchmark site was established as part of a "Water Table Management for Crop Production" study presently being carried out by the Soil Science Department at the University of Manitoba as an agro-man demonstration project. Nine toposequences were instrumented with water table observation wells. Wells and neutron meter access tubes were located at

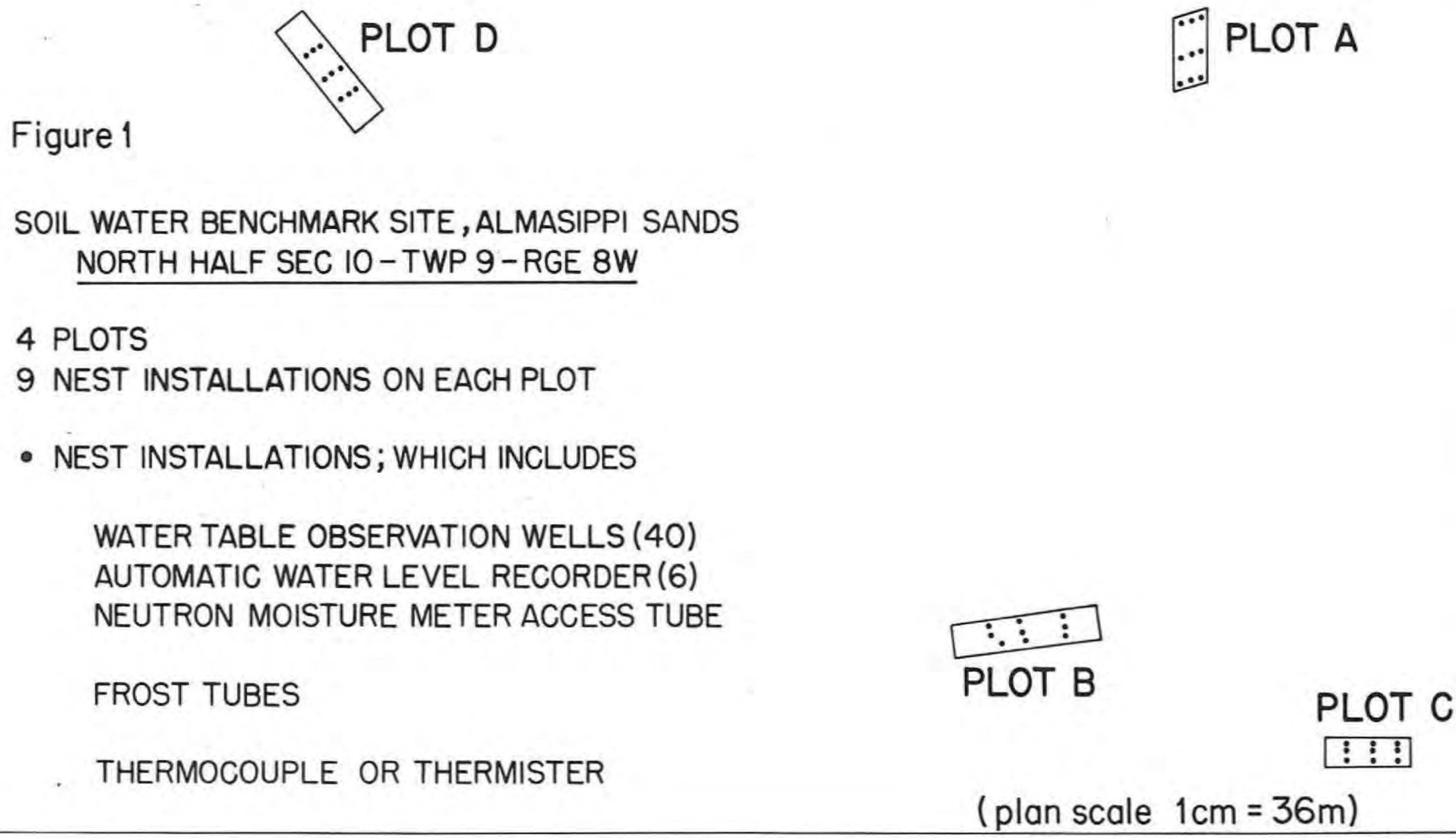

Figure 1

SOIL WATER BENCHMARK SITE, ALMASIPPI SANDS
NORTH HALF SEC 10 - TWP 9 - RGE 8W

upper, mid and lower slope positions and monitored at weekly intervals during the growing season. Thermisters, thermocouples and "frost tubes" were installed on five of these toposequences and will be monitored at the same time as the water table observation wells. Six automatic water table recorders were installed in the spring of 1982, along with a continuous recording rain gauge and minimum and maximum air temperature. The water well and soil temperature instrumentation has been replicated three times on 4 of the toposequences to study water regimes under three different cropping systems: alfalfa, barley, and corn. Figure 1 shows the general layout and design of the site, location and size of plots are to scale.

The soil types being studied are well, imperfect and poorly drained members of the Almasippi soil association. These are porous, fine sandy soils characterized by high seasonal water tables and irregular topography. The chemical and physical properties of the soils will be studied in relation to the dynamics of water table. Crop yields and soil properties will be characterized under natural water table conditions and under two depths of artificial drainage (tile). It is anticipated that this will be a 4-year study, and it is hoped that a better knowledge of the soil temperature and water regimes according to SWIG will evolve for wet porous sandy soils in Manitoba.

2. Soil Climate Studies in the Thompson Clay Belt (SCTC) - (Soil Survey - MDA)

A second benchmark site was established jointly with the Soil Climate Working Group in an area of discontinuous permafrost northeast of Thompson, Manitoba. The dominant soils in this area are lacustrine clay and bog veneers. Water table observation wells, piezometers, and thermocouples were installed in a toposequence and will be monitored at 5 to 6 week intervals. Detailed descriptions of soils, vegetation, soil temperatures, frost table configuration and water table configuration will be made over a period of the next several years. It is hoped that this data will be useful in formulating SWIG criteria for Cryosolic soils.

3. Ochre River Tile Drainage Project - (MDA - Soil Survey)

A third SWAB site has been established in cooperation with regional staff of the Manitoba Department of Agriculture, near Ochre River, Manitoba as a drainage project under the Agro-man program. The soils consist of shallow lacustrine clays to clay loams which are affected by seepage water. Wells and thermocouples have been installed in conjunction with plastic drain tile. Climatic data are also being collected at the site. The data being collected will be used to test the SWIG criteria as they might be applied to wet clay soils. Detailed soil characterization studies will be done in 1982.

4. Soil Morphological and Hydrological Study - (U. of M.).

A fourth site is situated in an area of hummocky glacial till near Manitoba. This site has been used as a student PhD. thesis project and has been instrumented with water table observation wells, piezometers and thermocouples. Data has been collected for several years and it is hoped that this site can be maintained for several more years as SWAB and SWIG.

All sites have been designed and are being monitored in close cooperation between Soil Survey and other agencies. All are multipurpose sites.

It is anticipated that a large volume of data will be collected from these SWABS in the next few years. This has led to consideration of the development of a soil monitoring file for CanSIS, to automate storage and analysis of soil water and temperature data.

The value of this data lies in building a long term record of observations. Soil climate characterization (temperature and moisture) should be approached in the same manner as atmospheric climate, that is, by collecting continuous records of observations for a reasonable number of years. This approach should give a better indication of the range and variation of soil climate conditions, and should help to define soil water regimes into SWIG classes. One of our biggest handicaps in using SWIG for soil mapping is the "one short" approach for observing soil water (moisture) conditions at a specific site. The monitoring and site descriptions should help us to make better estimates of the seasonal and annual water regimes of soil series.

The depth of the water table data obtained from individual water table observation wells, whether they are isolated installations or from part of a more detailed SWAB site, can be used to infer much about the water regime of the soil. Interpretation of depth to water table data from single observation wells is most useful for extrapolation in level homogeneous soil materials. On the other hand local relief and heterogenous soil conditions may severely restrict the extrapolation of soil water table data even for relatively small areas. Therefore to interpret data from individual wells. It is important to have good site and materials descriptions.

In Manitoba water tables in shallow (3 m) observation wells have been monitored as a routine procedure in many detailed (1:20,000) mapping projects. The length of the monitoring is usually determined by the duration of the project unless it is within easy access of Winnipeg. Analysis of accumulated data, other than plotting on a time scale, has not been attempted to date largely because the data remains in manual mode storage.

Figure 2. is presented as an example of one approach that could be considered for display, interpretation and extrapolation of soil water table and temperature data for individual site installations. Figure 2 has been designed to illustrate the relationships between precipitation, water table levels and soil temperature data. The horizontal axis is the time scale. This bar graph on the bottom is a plot of the monthly totals of precipitation for the nearest recording station. The CPD graph (plot of the cumulative precipitation departures from the long term monthly mean) is useful for assessing ground water level trends and for predicting the magnitude of water table response to precipitation events in shallow unconfined aquifers. (Schofield 1960).

Soil temperatures are plotted for the 50 cm depth zone although the appropriateness of the 50 cm depth as compared to other depths has not yet

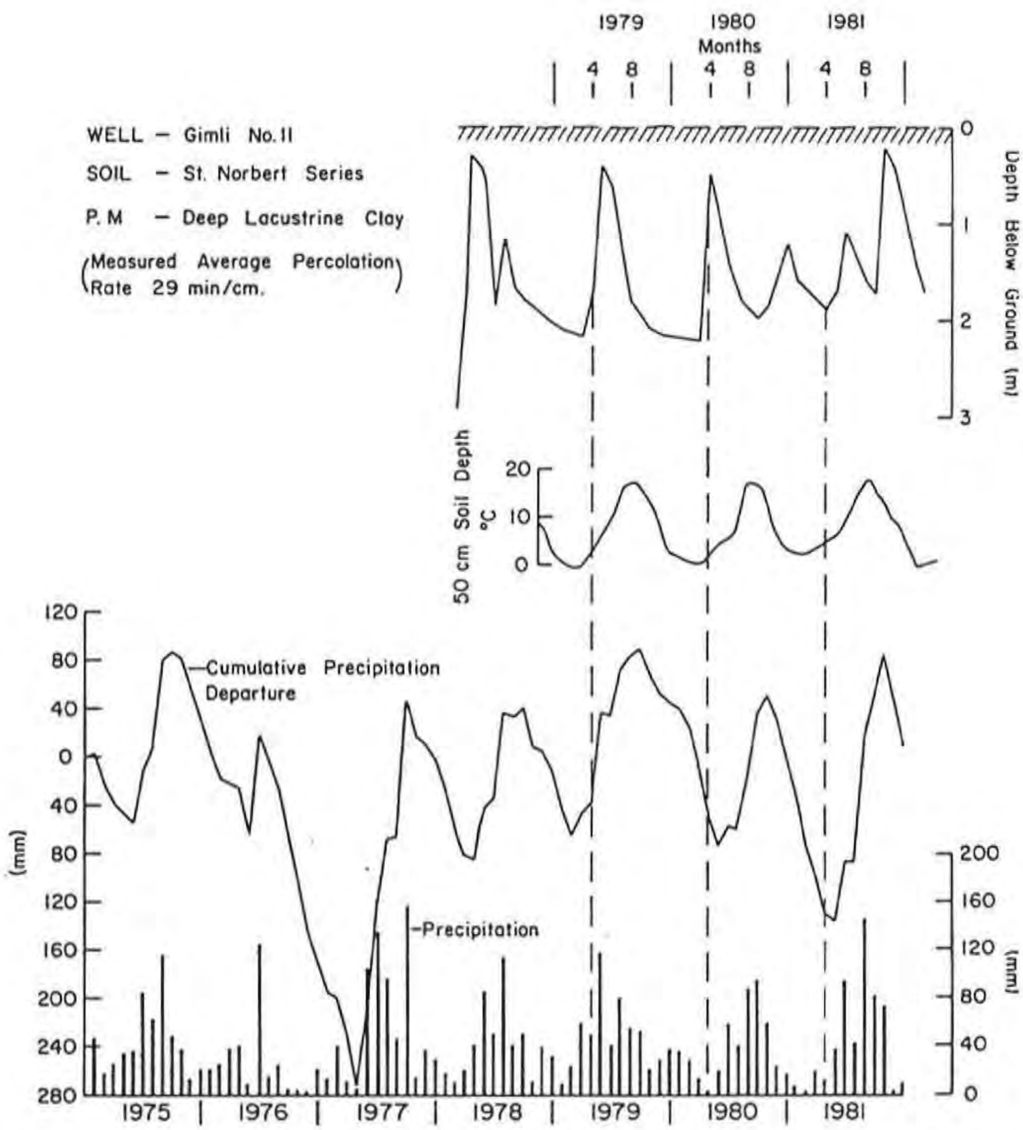

Figure 2. Soil water and temperature data for a St. Norbert clay soil near Gimli Manitoba.

been determined. A time series plot of the depth to water table readings shows a seasonal as well as annual cyclical water table fluctuation. These graphs indicate;

1. The annual peak or highest water tables occur in month four which corresponds to the disappearance of frost in the soil at the 50 cm level. This indicates the dependance of soil water regimes on soil temperatures.
2. The magnitude of the water table response in this soil is more related to frost conditions in spring than to the magnitude of precipitation events later in the growing season.
3. There is a distinct lag time (approximately 1 to 2 months) between the total montly precipitation and the associated water table response.

The St. Norbert soil at this site is classified as a moderately well to well drained orthic dark gray (Chernozemic developed on moderately calcareous, fine textures (>70% Clay) lacustrine deposits. According to SWIG (1981) this soil would have no significant moisture deficit, a slow hydraulic conductivity, average high water tables of 50 to 100 cm. persisting for a short duration (2-20 days) and an average low water table of >200 cm. The site is not affected by seepage or artificial drainage. However, the soil water regime is affected by soil temperature frost lensing creates surface saturation in spring by restricting infiltration of snow melt. The necessity of having a close working relationship with the soil (temperature) climate group. The definition of soil temperature-water relationships as well as the integration of these relationships into soil taxonomy should be one of the long range goals of these working groups.

OTHER CONCERNS

Regarding the criteria for K classes proposed by SWIG, 1981, several suggestions came forth in 1981 for revised limits. The proposed changes are summarized in Table 2. There is really not a great difference between any of the 6 proposals, especially for the "M" class. There are probably many good reasons for each of the proposals, but at this stage I would recommend that we adopt the standard values used by USDA. The USDA criteria utilizes only 1's and 5's and thus we only have to remember where to put the decimal when trying to make these estimates. However, the USDA classes have fewer splits on the finer and; if this is a problem we could make 1 or 2 additional splits. As pointed out by Clarke Topp this gives a uniform range factor or 3 or 3.3 between classes.

Remember that the class limits established must be of a suitable format that will facilitate their adoption and use in the field by soil mappers and pedologists. The degree of difficulty and confidence required to make these estimates increases rapidly as the number of options and ranges of limits increases. I personally like the idea of having two levels to choose from as is presently indicated in the SWIG system, i.e. high, medium, and low. The options to identify subdivisions within these three ranges are available for use if data are available or if the soil surveyor feels sufficiently confident to estimate these narrower categories. I also like the idea of applying these "K Sat." classes to soil horizons or layers as well as an overall estimate for

Table 2. Recent suggestions for Symbols, Definitions, and Value ranges for Hydraulic Conductivity Classes for Soil Water Regime Classification.

Symbol	Description	SWIG[1] 1980	D. Cote[2] 1981	A. Mack[3] 1981	Wang &[4] McKeague 1981	Manitoba[5] Soil Reports	USDA[6] 1979	C. Topp[7] 1982	8
H	High	>16.7							
H1	Very Rapid	>50	>40	>37.6	>45	>25	>50	>50	H2
H2	Rapid	16.7-50	40.4	<37.6	15-45	15-25	15.25	15-50	H1
M	Medium	0-42-16.7							
M1	Moderately Rapid	4.2-16.7	0.4-0.04	<13.76	5-15	5-15	5-15	5.0-15	M3
M2	Moderate	1.7-4.2	0.4-0.04	<3.76	2-5	2.5-5.0	1.5-5	1.5-5.0	M2
M3	Moderately Slow	0.42-1.7		<1.37	0.5-2	1.5-2.5	0.5-15	0.5-1.5	M1
L	Low	<0.42							
L1	Slow	0.17-0.42	0.04-0.004	<0.370	0.1-0.5	0.125-1.5	0.15-0.5	0.15-0.5	L3
L2	Very Slow	0.017-0.17	<0.004	<0.037	0.02-0.1	<0.125	<.15	0.05-0.15	L2
L3	Extremely Slow	<0.017		<0.0037	<0.02			<0.05	L1

1 Proposed SWIG Classes - from ECSS Meeting, Mar., 1981.

2 Proposed in correspondence to chairman of SWIG.

3 Proposed in correspondence to chairman of SWIG.

4 Proposed in correspondence to chairman of SWIG.

5 Values currently used in published soil survey reports in Manitoba.

6 Values published and used in the North Dakota Irrigation Guide Book (converted to metric).

7 Values have a uniform range factor of 3 or 3.3 except for L2 and there are only 0,/'s, +5's in the limits.

8 Suggestion for re-numbering; increasing numbers for increasing values.

the soil series which will probably be determined by the most restrictive layer in the soil. In Manitoba soil permeability estimates are currently made for soil series on a horizon or layer basis as a routine part of the engineering section of soil reports.

2. Soil Water Investigation Methods Mannual (SWIMM)

The following activities are currently under way;

1. A documentation and reference of field procedures presently used in each province to measure and monitor soil water regimes. A list of these procedures is being compiled.
2. A list of field clues for estimating hydraulic conductivity is being compiled. These clues should be useful to soil mappers during routine field inspections and for detailed soil descriptions.
3. A list of some "rules and thumb" that pedologists use (or could use) to describe and interpret soil structure and assess its influence on the hydraulic conductivity in the unsaturated soil zone, and the persistence of water table within a certain depth from the soil surface is being developed.
4. A tentative outline for the methods manual has been developed and an initial draft is being compiled.

A Tentative Proposal for "SWIMM" (Outline)

Soil Water Investigation Methods Manual INTRODUCTION

Brief historical review of Soil Drainage Classification (Canada) Reasons for Manual

OBJECTIVES OF THIS MANUAL

A. FIELD PROCEDURES

I. METHODS FOR MEASURING SOIL WATER PROPERTIES
   1. Unsaturated Soil Zone
      .1 Hydraulic Conductivity
      .2 Infiltration
      .3 Percolation
      .4 Field Capacity
      .5 Soil Texture
      .6 Bulk Density
      .7 Porosity
      .8 Others

   2. Saturated Soil Zone
      .1 Hydraulic Conductivity
      .2 Water Table
      .3 Capillary Potential
      .4 Porosity
      .5 Saturation Persistence
      .6 Others

II. PROCEDURES FOR ESTIMATING SOIL WATER PROPERTIES
   .1 Unsaturated Soil Zone
      i) Bio-Pore Description
      ii) Characteristics of Soil Structure
      iii) Soil Texture
      iv) Etc.
   .2 Persistence of Saturation
      i) Soil Colors
      ii) Description of Mottles
      iii) Etc.
   .3 Soil Water Regimes
      i) Soil Horizon Sequences
      ii) Solum Thickness
      iii Landscape Characteristics (Recharge - Discharge)
      iv) Etc.
   .4 Water Regime Modifiers
      i) Man-Made Modifiers (e.g. identified in SWIG Proposal)
      ii) Natural Modifiers (e.g. flooding, etc.)
   .5 Others

III METHODS OF INSTRUMENTATION (FIELD)

1. Design and Installation of Wells and Piezometers
2. Monitoring Procedures
3. Sampling Procedures
4. Etc.

B. LABORATORY PROCEDURES

Methods of Measuring Soil Water Properties

(Could include a list of simple routine lab methods for hydraulic conductivity and other properties, F.C. B.D., etc. which soil survey labs could adapt. Is it possible to recommend a commonly used or most appropriate method? Different soil textures may require different methods.)

C. DATA PRESENTATION AND INTERPRETATION

(Some guidelines or examples will be included)

D. TERMINOLOGY FOR SOIL WATER REGIME CHARACTERIZATION

Definitions - well, piezometer, water table, recharge, discharge, aquifer, etc.

E. REFERENCES

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P.F.R.A. - SOIL INFORMATION REQUIREMENTS

Lynn Chambers

Since its inception in 1925, P.F.R.A. has had a mandate to provide soil and water conservation programs. Two of the long established programs, Community Pastures and Tree Shelterbelts, are well known in Western Canada. Millions of dollars are provided annually to assist farmers with wells and dugouts. Major reservoir projects such as St. Mary's Waterton, Gardiner, Shellmouth and Rivers, have added experience and credibility to P.F.R.A. as a major water developer. Although we do have our own geotechnical laboratory on campus at the University of Saskatchewan, P.F.R.A. engineers and agrologists have utilized soil survey information extensively for many years.

The droughts incurred in Western Canada during the 60's, 70's and again in 1980, have created a renewed interest in soil and water conservation.

P.F.R.A. is again being called upon to provide some leadership, both in expertise and finances. Irrigation proposals are now being considered in all three prairie provinces. Soil degradation problems related to water and wind erosion, increasing soil salinity, and decreasing fertility have sparked new initiatives in programming. P.F.R.A. appreciates the dedicated work of Soil Survey and the demands constantly being requested from the many users of soils information. We also appreciate this opportunity to bring forward some of our immediate needs and seek the advice and assistance of the Committee in these areas.

In 1964, P.F.R.A. published a "Handbook for the Classification of Irrigated Land in the Prairie Provinces". Technology has changed dramatically in the last 20 years and with it came changes in irrigation systems. It seems there is a general consensus by professionals that the old handbook is outdated and revisions are needed. We in P.F.R.A. concur with this view. Last fall Dr. Harry Hill chaired a meeting of twenty-five engineers, pedologists, agrologists, hydrologists and research scientists in Saskatoon to discuss some of these concerns. Resulting from the meeting was the naming of a Task Force to review the criteria and standards required to classify irrigation land and bring forward recommendations for change.

Our progress to date has been slow but some concepts are emerging. There appears to be a need for two levels of interpretation required for irrigation planning and development. The basic data needs are the same although the intensity may vary, depending upon the use.

The first need is that of planners for project proposals and feasibility studies. The interpretation here requires a suitability rating for irrigation which includes a textural separation and drainage requirement. Although basic physical and chemical properties are important, their interpretation into uses and constraints is the information used by the planner.

The second need comes from engineers, agronomists and economists who carry out the actual project design planning. At this phase, interpretation from others are of little importance as each professional is required to make his own interpretations from the data available.

The role of the soil scientists carrying out soil surveys would seem to encompass the identification and recording of soil properties to satisfy these two needs. If this data is collected under a set of standards, and if the range of properties was established for each suitability class, then it is conceivable that interpretations by soil survey pedologists would not be required. Again, if this data was stored in a readily accessible format and could be cartographically displayed, interpretations and map production would then relate to individual users needs. The CanSIS system appears to have the capability to satisfy this requirement.

On the technical side some new evaluations are required of criteria, which were previously considered constraints. For instance, sprinkler irrigation has greatly lessened topography as a constraint. Should clay soils be down-graded due to low permeability and infiltration if sodium salts are not present in the profile? Intake rates are prime criteria considered by irrigation engineers. Do we need more research in this area or is an interpretation based on texture, structure, permeability or hydraulic conductivity adequate?

After reviewing the minutes of the Committee's previous meetings, we are aware that user brochures are in the process of being prepared. These brochures describe how to utilize interpretations. If our previous suggestions were adopted then preparation of manual describing how to make interpretations and how to use soils information in detailed design and project planning may be appropriate. These manuals could then serve as a replacement for the old 1964 handbook.

PFRA is presently involved in the planning of major program activities in the area of soil conservation. We will be making extensive use of the information available in various soil survey reports and accompanying maps for Alberta, Saskatchewan and Manitoba, initially for diagnostic purposes and subsequently for program development and implementation. While detailed and elaborative data needs will be discussed directly with various Soil Survey Sections as well as with the Committee Members in future meetings, some of the information which will be helpful in our program activities, are listed below:

1. Estimates of Soil Salinity
   - Extent: percent or area surveyed, size of the area affected in terms of hectarage.
   - Nature of Salinity: dryland, residual and irrigated salinity, alkalinity (solonetzic/sodic soils).
   - Severity of Salinity: types and amounts of salts.
2. Depth to Water Table
   - Analysis of Water: electrical conductivity and types of salts.

3. Infiltration Rates (may assist in identifying recharge areas, irrigation suitability and other implications).

4. Water Holding Capacities.

5. Section of vegetation could be expanded. Plant species as indicators of soil salinity.

6. Salinity Ratings: comments pertaining to risk of becoming salinized (slight, moderate, or severe).

7. Extent and Severity of Soil Erosion.

8. Potential Erodability Rating.

9. Texture: request inclusion of very fine sand fraction in particle size analysis (for use in U.S.L.E.).

10. Slope Length: average length of slope within a mapping unit.

We appreciate that some of the above information exists in some of the soil reports. Our major concern is the lack of consistency of data gathered and recorded between Soil Survey Units. Again, if the data was standardized and if it were stored in a readily accessible form, then the user could retrieve that data required to satisfy his needs.

We are hopeful that the type of information we require will be digitized and sorted in the CanSIS system as soon as it becomes available.

SOILS IN "QUATERNARY GEOLOGY IN CANADA"

D.F. Acton

Introduction

The Geological Survey of Canada is currently revising "Geology and Economic Minerals of Canada". In addition to providing an updated synthesis of Canada's geology, this will be Canada's contribution to the Centennial Project of the Geological Society of America, Decade of North American Geology.

This is the sixth revision of the Geology and Economic Minerals of Canada. It will consist of as many as nine volumes, each being up to 400 pages in length. One volume will be devoted to Quaternary geology.

The Quaternary geology volume will consist of two main parts. The first part describes the Quaternary geology of different regions of Canada. Regions about which areal geology chapters will be written are: Cordillera, Plains, Shield, High Arctic, St. Lawrence Lowlands, and Appalachians. The second part deals with topical aspects of Quaternary geology and the interactions of these with the operations of man. Topical chapters cover: Quaternary environments, Quaternary processes, Quaternary geodynamics, terrain geochemistry, land use and planning, and Quaternary resources.

The Quaternary volume will be accompanied by a surficial materials map of Canada at a scale of 1:5,000,000. Units on this map will be defined primarily in terms of nature of materials but a secondary classification based on age will be made where appropriate information is available.

The Quaternary volume will have a 400 page limit. Chapters, such as Quaternary Resources will vary from 15 to 40 pages. The entire volume is to be ready for final editing by the end of 1984. R.J. Fulton is the editor of the entire volume and Lionel Jackson of the GSC in Calgary is co-ordinator of the "Resources" chapter.

A request from R.J. Fulton of the GSC to include a section on Soils in the chapter on "Quaternary Resources" was received by J.H. Day. The latter considered this to be a matter for consideration of the ECSS and asked me to bring forward a plan of action.

Content

Lionel Jackson suggested that the soil section 'will interpret and discuss the influence of Quaternary geology on the soils of Canada. Specifically, the distribution of soils in Canada at the sub-order level will be presented in map form. The role of surficial geology in the distribution of the sub-orders will be discussed along with the general basis for definition and identification of these soil groups. The role of Quaternary geology and history on the arability and productivity of the soils will be disussed. Finally, the application of

SOILS IN "QUATERNARY GEOLOGY OF CANADA"

Quaternary geology to soil mapping will be discussed. To this, R.J. Fulton added that he would like to see the section include the following: What is soil in a pedologic sense? Soil development - what is it; what are the controlling factors; what results. Role of surface geology in soil development; soil utility. Application of Quaternary geology in the work of a pedologist.

Subsequent to this, I met with Lionel Jackson to get a better idea of the purpose of the publication, who the anticipated audience is. On the basis of this discussion, I have developed a tentative outline, presented as Appendix I.

Strategy

Two strategies are proposed:

Strategy 1. A one-man committee be appointed to prepare this document in its entirety. (I am naive enough to believe this has not already been done.)

Strategy 2. One person to act as co-ordinator of a group of 5 or 6 persons, with each of these persons assigned authorship of a specific aspect of the text, i.e. Soils of the St. Lawrence Lowland or Dynamics of Soil Formation.

Realizing that we have a suggested limit of 8 pages of text, it is tempting to suggest that we should opt for strategy 1. To do otherwise may "open the door" to devoting more resources to the activity than is warranted. On the other hand, a national perspective to the presentation may be enhanced by selecting contributors from across the country. What is your choice?

Outline

Title: Soils

1. Introduction

1.1 What is a soil
1.2 How do soils form (in a general sense)
1.3 Relationship of soils and geology
1.4 The Scientific study of soils
- who does it
- for what purpose
- application of surficial geology
- references

2. Soils of Canada

2.1 Introduction
2.2 Soil of the Cordilleran
2.3 Soils of the Interior Plains
2.4 Soils of the St. Lawrence Lowlands
2.5 Soils of the Appalachians
2.6 Soils of the Arctic
2.7 Soil map of Canada - on one page

3. Dynamics of Soil Formation

3.1 An integrated, conceptual diagram depicting how soils form.
3.2 Narrative focusing on processes and rates of formation.

RESEARCH NEEDS ON WATER IN AGRICULTURE

Research Branch Work Planning Meeting
Lethbridge, January 12-14, 1982

John L. Nowland

The two and one-half day meeting was convened to formulate recommendations to the Research Branch of Agriculture Canada on the content and priorities of a research program on Water in Agriculture. A report was prepared that summarizes important issues that were raised, makes recommendations for action, states the priorities for research, provides highlights of 33 presentations, and records regional critiques. This summary is for information and does not reflect the policy and views of the Research Branch.

Major issues of concern were:

- The requirements for a "national framework study" leading to a National Water Policy. The Policy would help determine the future allocation of water to agriculture, and plan major thrusts of research (to meet a projected "water crisis")

- The rationalization of national versus regional priorities.

- The interrelationship of conservation, irrigation and drainage technologies as we move into a new era of "water management".

- The need for "adaptation research" and improved transfer of technology.

- The recurrent call for more interdisciplinary integration and research-team approach.

- The understated importance of basic physical research.

Some of the recommendations were:

1. The current level of funding, approximately $2.53M in 1981 to be increased by $1.5M in 1983-84, and augmented thereafter in line with program proposals in the Agri-Food Strategy.

2. Professional person years to be increased by 35 over 5 years, plus adequate technical support.

3. Program 2, Water in Agriculture, in the Agri-Food Strategy proposals to be assigned high priority.

4. The research priorities presented in the report to be accepted for program planning purposes.

Research Priorities are presented under suggested program titles.

Priority 1 (four or five programs)

1.1 Precipitation Use Efficiency. Projects to maximize efficient use of existing water supply to crops, under dryland systems which are viewed as the chief source of increased crop production.

1.2 Irrigation Water Delivery Efficiency. Projects to overcome existing irrigation problems, essential for expansion and more efficient use of scarce water.

1.3 Soil Salinity Control. Projects to solve the most serious land degradation problem on the Prairies.

1.4 Water Management on Wet Soils. Projects to improve persistently and intermittently wet soils, at reduced cost, with minimal environmental impact.

1.5 Economic Assessment of Expanded Irrigation, Land Drainage and Dryland Production. An optional grouping of economic feasibility studies extracted from the previous 4 programs, designed to fill a serious information gap in program and policy planning.

Priority 2 (8 programs)

2.1 Soil Water Inventory. Improved basic data collection, in support of researchers and farmers, an expanded role for soil survey.

2.2 Methods and Instrumentation for Measuring Soil Physical Properties. Basic research identified as essential for irrigation planning, control of salinization and improved management of wet soils.

2.3 Climatic Studies for Improved Forecasting. Projects on crop-climate relationships and climatic variability to reduce producer's risks, and costs.

2.4 Fertilizer Requirements of Irrigated Soils. Research on alternative techniques to fit this special situation and reduce costs, and risks of soil degradation.

2.5 Soil Irrigability Standards. Research to define criteria for planning expansion in new areas.

2.6 Farm Irrigation Scheduling. Projects of adaptation of technology in commercial situations to remove a demonstrable shortfall in productivity.

2.7 Impact of Irrigation on Surface and Ground Water Resources. Research on water and salt movement for regulating leaching and its impacts on water resources.

2.8 Control of Water Erosion. Projects designed to produce and demonstrate practical controls for erosion and compaction, thereby asserting responsible stewardship for land quality.

Priority 3

3.1 Soil Moisture Monitoring Survey. Not research, but an information service to producers, (now operating in Saskatchewan).

3.2 Field Interpretation Tools and Adaptation Research. Projects to demonstrate to farmers the effects of changed techniques (especially for conservation), for which cost and dimly perceived benefits may be deterrents.

3.3 Management Modelling. The development of input-output crop production models to improve evaluation of alternative production systems.

3.4 Management of Impaired Water for Irrigation. The maintenance of necessary expertise in recycling a resource while solving a disposal problem.

3.5 Water Management on Organic Soils. Research on the key problem in managing an enormous Canadian resource, and reducing its cost.

3.6 Basic Soil Water Research. Vital research on water movement in soil and measurement techniques. Some such work is incorporated in other programs in varying degrees, but a unifying program theme all its own might better ensure its health.

Report of Soil Correlation Working Group

J.H. Day

Soil Survey Form 1 (Planning document) 1981 was discussed. Its objectives were rediscussed and opinions of its utility aired. In general, most groups thought it very desirable especially for projects of longer duration, but that the instructions for its completion inadequate. An example completed by Saskatchewan utilizing a word processor was discussed. A revised version compiled by the chairman was presented. It utilized the Saskatchewan project details in a format revised to present summary statements of objectives, background, and resource requirements useful to sponsoring agencies, and detailed statements of technical plans in the following position.

Persons present agreed to test the 1982 version on new projects initiated this year in Elgin County Ont., Hants County NS, Robinson's County, NF, and Westbourne County, MA.

Soil Survey Form 2 (Correlation document) 1981 was discussed. Its acceptation by survey units remains at best lukewarm. Although there is general agreement of a need for such a document, the amount of detail in the present document is the principal complaint emanating from the few respondents. The correlation group in Ottawa is of the opinion that the form should remain as published in the Third ECSS 1981 Proceedings, and that revisions should be undertaken after it has been used and evaluated by most groups in this year.

The opinion was expressed by several persons that a two to three day workshop of SSF2 should be convened in order to effect the required modifications.

Recommendations

1. Adopt the 1982 modification of SSF1 for use, evaluating its suitability at the next meeting.

2. Text the 1981 version of SSF2 in designated project areas and evaluate responses of agencies as to the nature and degree of modification required. At the next annual meeting present a proposal for modification.

GENERALIZED SOIL LANDSCAPE MAPS - A PROGRESS REPORT

J.A. SHIELDS

During the past several months much of my time has been allocated to the above topic. Essentially this work is a follow-up to decisions documented in the Third Proceedings, particularly with respect to decisions on class limits of differentiating soil landscape properties (genetic materials and its texture, surface form, slope gradient). The decision reached concerning the publication map symbol format has also been adhered to (texture of genetic material, dominant soil development, surface form, slope gradiant, unique polygon number).

An open working legend was developed (see portion attached in Table 1) and tested in southern Saskatchewan. The codes for texture of genetic materials was prepared in consultation with Cliff Acton who is compiling a genera map of Ontario. This coding scheme was comprehensive enough to accomodate textures of materials encountered in the Southern Prairie and Ontario. It is also noteworthy that surface form and general materials of organic soils were added to the legend. This was done in consultation with Charles Tarnocai.

The next step was to prepare an extended legend listing the dominant and subdominant soil (or non-soil) landscape properties characteristics of each polygon. This extended legend eventually evolved to a computer legend coding format (see portion attached in Table 2) on which can be encoded most of the important soil landscape features within each polygon. These forms have been completed for the maps of Southern Sask. and Manitoba. The unique polygon number provides the linkage between map and extended legend. Details of the coding procedure are given in Table 3.

In the case of soil development, Taxonomy was used as a tool for organizing soil properties into sensible classes established by experience. Taxonomy not only conveys information about soil behavior but also allowed for correlation between previously mapped areas and provided a convenient form of shorthand. From the onset of the generalization procedure, it was clear that no one level of Taxonomy was suitable to characterize all selected differentiating soil properties. According to the objectives of the project, it was concluded that the Great Group level was satisfactory for soil properties characteristic of Chernozemic and Brunisolic soils and the Order level for Regosolic and Gleysolic soils.

Mapping Procedures

During compilation of the Sask. map I went back to "square one" and generalized the most recent soil maps conveniently available. These ranged from:

(1) Full color maps (1:126,720). - The color patterns hastened delineation of soil development, genetic materials and its texture.

(2) Black line, soil - landform maps (1:250 K).

(3) Soil Survey No. 12 for Tp 46-48 (1:500 K).

(4) Soil Survey No. 13 (1:190 K).

With few exceptions, two basic rules were not to delineate areas smaller than 1 township or drainage channels narrower than one mile. Other rules focussed on the similarity and degree of limitation (non-limiting -limiting) of soil components within an area. For example, a change in any differentiating property class which was similar and non limiting but occupying 40% of the area resulted in a new polygon. In contrast, occupance of only 15-20% of an area by dissimilar, limiting property classes resulted in a new polygon. All generalized maps were then photo reduced to a scale of 1:1 million and mozaiced by overlaying on a stable base supplied by the Cartographic Section. The resulting map was then forwarded to Don Acton in Saskatoon for local editing. On return it was digitized.

In the case of Manitoba, their Generalized Soil Map was checked against the 1:1 million soil capability map. Map symbols were then assigned to the resulting polygons and the dominant soil landscape properties coded on the computer legend. The map and legend were sent out to Bob Smith and Gordon Mills (and others) who took considerable time to review and revise my initial efforts. Thanks to them we ended up with a reliable map.

A similar procedure was followed for the map of southern Alberta. The major river valley and glacial spillways were outlined from the soil capability map. This was overlain by polygons from the Alberta Physiographic Map (Pettapiece Sept./80). Zonal soil boundaries were then superimposed followed by polygons from the Solonetzic Soils map. Minor modifications were also made according to some of the more recent Soil Survey Maps. The resulting map was then sent to Wayne Pettapiece and Andy Kjearsgaard for editing. Their revisions certainly improved the reliability of the map.

Scheduling

It is proposed to complete the Prairie Agricultural Region including the Alberta and B.C. Peace River Areas by march 31, 1983. There is also sufficient local interest to complete the maps for Northern Manitoba and Saskatchewan by the same date. To date, there has been no commitment to complete Northern Alberta. Hopefully, this can be achieved by 1984? I am prepared to make a commitment for the Peace River area. However, a large wilderness areas remains.

Current Data Gaps

Information gaps become apparent as we encountered the wildland areas. Information on organic landforms is lacking in many areas of Northern Saskatchewan (and probably Alberta). A second concern is the need to characterize permanent water bodies and to document their differentiating or description role in soil landscape mapping. A tentative proposal has been put forward by Charles Tarnocai and his colleagues who are using features observable from Landsat when mapping northern terrain (Table 4).

Publication Legend

After exposing the working legend to a number of colleagues it became evident that it was not suitable as a publication legend. Although it seemed simple and understandable to it originator, it presented difficulties to those people not using it every day. Consequently, two other alternatives have been proposed for the publication legend; both are closed formats. The first is a standard closed format displaying the color key and map symbols for the texture of genetic material along the left hand side followed by symbols and a description of surface form and slope gradiant class. The legend components are grouped vertically according to soil development (see Table 5).

The second closed legend simply rearranged the columns described above into an "axial" format. The most important column containing symbols in colored boxes is placed towards the centre of the legend forming its axis. To the left is information describing the texture of genetic materials. To the right is information describing surface form and slope gradiant (Table 6).

Applications

Present applications will focus on single factor retrieval maps. Dick Coote is currently using information on surface texture for assessing wind erosion potential. Present applications also include interpretation (or derivitive) maps based on information from more than one coding from "field".

Future applications are dependent on additional information input to the extended computer legend. Possibilities include data on climate, soil moisture deficits, soil temperature, agricultural land use systems and crop yields.

Future Considerations

Inputing additional data to the extended legend is of prime concern. Some of these are listed in the preceeding paragraph. Concern has also been expressed about creating a linkage between the present extended computer legend and the soil data file.

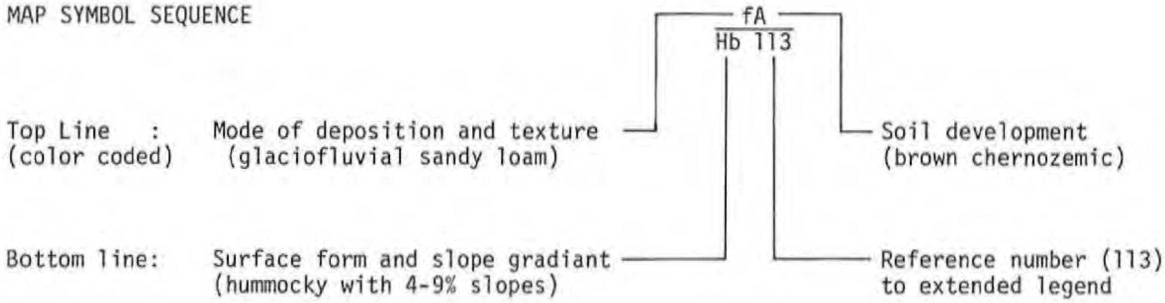
Publication format of maps and extended legend must be finalized shortly. Two formats have been proposed:

1. Colored maps with legend for south part and north part of each province as per the CLI map series at 1:1 million. An extended legend in booklet format would be available on demand.

2. Atlas format consisting of colored maps and selected black and white single factor and derivative maps. In order to have a sensible size (18" long, 14" wide) for the Atlas, each Province would have to be divided into 3 equal parts from South to North. Each of these parts would have a fold out to accomodate the required width. Legends would be printed on the back of the preceeding map (i.e. opposite page). The extended legend would be available in booklet format.

Preliminary discussions with participating provinces indicate a preference for proposal 1. A firm decision is required in the near future because it influences decisions concerning digitization of these maps.

Table 1. Example of working legend (open format)



The above example indicates a brown chernozemic soil developed on glaciofluvial sandy loam material with a hummocky surface form and 4-9% slopes.

WORKING LEGEND

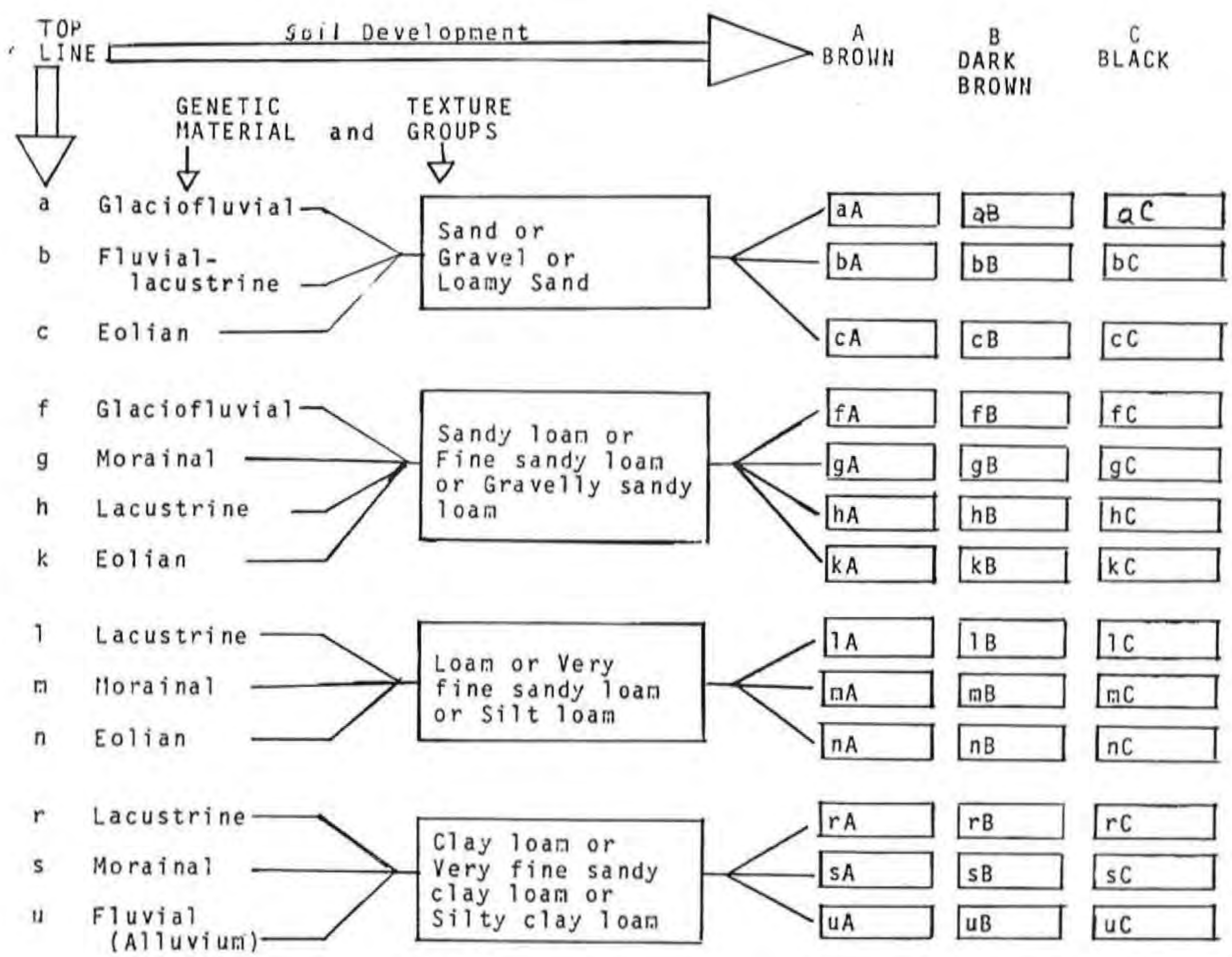


Table 1. (continued)

v	Lacustrine	Clay or Silty clay or Heavy clay	vA	vB	vC
x	Morainal		xA	xB	xC
y	Fluvial (Alluvium)		yA	yB	yC
z	Undifferentiated Loam or Clay Loam		-	-	-

11 Fibric Sphagnum

21 Mesic Sedge

23 Mesic Woody Forest

BOTTOM LINE — Slope Gradiant Class	a 0-3%)	b (4-9%)	c (10-15%)	(16-30%)
- MINERAL SURFACE FORM				
D Dissected or gullied pattern providing drainage from an area	Da	Dd	Dc	Dd
H Hummocky pattern with chaotic sequence of pronounced knolls and swales	Ha	Hb	Hc	Hd
K Hummocky pattern with chaotic sequence of knolls and numerous kettles (or sloughs) which occupy 15-20% of an area	Ka	Kb	Kc	Kd
L Level or nearly flat featureless pattern	La	-	-	-
M Rolling pattern with a regular sequence of long, moderate slopes rising to broad, rounded convexities	Ma	Mb	Mc	Md
R Ridged pattern with a sequence of long narrow sharp crested ridges and accompanying swales	Ra	Rb	Rc	Rd
U Undulating pattern with a regular sequence of gentle slopes	Ua	Ub	-	-

Table 2. Example of Computer Legend Format For Prairies

Soil Capability C=Class S=Subclass						Land Use								DOM. SOIL-LANDSCAPE												SUB.DOM SOIL-LAND.							NON SOIL									
C	S	C	S	C	S	%	Kind	Township T	P	Range R	G	Meridian M	MAP SYMBOL	P=Parent M=Material P	M	Text	Development	Surf Form	Slope	Surf. Text	AWC	CALC.	WATER T.	Soil Incl.	REG. FORM	P=Parent M=Material P	M	Text	Development	surf. Form	Slope	surf. Text.	DOM	Form Loc	Slope	Form Reg	SUBDOM	Form Loc	Slope	Form Reg	DOM DRAIN	SUBDOM DRAIN
1	2	3	4	5	6	7	8	9	10	11	12	13	14 15 16 17 18 19 20 21 22	23	24	25 26 27 28	29	30 31 32	33	34 35 36 37	38	39	40	41 42 43 44	45	46	47	48 49 50 51	52	53 54 55	56	57 58 59 60	61 62	63	64	65	66 67	68	69	70	71	72

TABLE 3. GENERALIZED SOIL LANDSCAPES COMPUTER LEGEND (30-03-82)

1. LOCATION OF POLYGON (i.e. TP, RG, M)
(Cols. 9-13)

2. GENETIC PARENT MATERIAL (MINERAL) (Col.14) — TEXTURAL GROUP

GENETIC PARENT MATERIAL (MINERAL) (Col.14)	TEXTURAL GROUP
a Glaciofluvial b Fluvial-lacustrine c Eolian d Marine e Colluvial i Morainal	sand loamy sand fine sand gravelly sand cobbly
f Glaciofluvial g Morainal h Glaciolacustrine j Colluvial k Eolian	sandy loam fine sandy loam gravelly sandy loam gravelly loam
l Glaciolacustrine m Morainal n Eolian p Colluvial q Fluvial (Alluvium)	gravelly silt loam very fine sandy loam loam silt loam
r Glaciolacustrine s Morainal t Marine u Fluvial (Alluvium)	very fine sandy clay loam clay loam silty clay loam
v Glaciolacustrine w Marine x Morainal y Fluvial (Alluvium)	sandy clay silty clay clay heavy clay
z Undifferentiated	loams and clay loams

GENETIC PM (ORGANIC)
(Col 18)

11 Fibric Sphagnum
21 Mesic Sedge
22 Mesic Woody Sedge
23 Mesic Woody Forest
24 Mesic Brown Moss
31 Humic Sedge
32 Humic Woody Sedge
33 Humic Woody Forest
34 Humic Brown Moss

NONSOIL MATERIAL (Col 18)

R1 Soft Rock Undifferentiated
R2 Hard rock Acid
R3 Hard Rock Carbonaceous
R4 Hard Rock Undifferentiated

3. SOIL DEVELOPMENT
(Col. 15; Col. 29; Col. 52)

A Brown Chernozemic
B Dark Brown Chernozemic
C Black Chernozemic
D Dark Gray Chernozemic or Luvisolic
E Gray Brown Luvisolic
F Gray Luvisolic
G Brown Solonetzic
H Dark Brown Solonetzic
J Black Solonetzic
K Gray Solonetzic
L Melanic Brunisol
M Eutric Brunisol
N Sombric Brunisol
P Dystric Brunisol
R Regosol
O Organic Cryosol
S Static Cryosol
T Turbic Cryosol
U Gleysolic
Q Humic Podzol
V Ferro Humic Podzol
W Humo Ferric Podzol
X Fibrisol
Y Mesisol
Z Humisol

4. SURFACE FORM - LOCAL
(Col. 16; cols. 30-32; Cols. 53-55; Col. 63; Col. 68)

D Dissected
H Hummocky
K Knoll and Kettle
I Inclined
L Level
M Rolling
R Ridged
S Steep
U Undulating
V Veneer

(Cols. 30-32; 53-55)

B01 Bog Palsa
B02 Bog Peat Mound
B03 Bog Mound

B04	Bog Domed
B05	Bog Polygonal Peat Plateau
B06	Bog Lowland Polygon
B07	Bog Peat Plateau
B08	Bog Northern Plateau
B09	Bog Atlantic Plateau
B10	Bog Collapse
B11	Bog Floating
B12	Bog Shore
B13	Bog Basin
B14	Bog Flat
B15	Bog String
B16	Bog Blanket
B17	Bog Bowl
B18	Bog Slope
B19	Bog Veneer
F01	Fen Northern Ribbed
F02	Fen Atlantic Ribbed
F03	Fen Ladder
F04	Fen Net
F05	Fen Floating
F06	Fen Stream
F07	Fen Shore
F08	Fen Collapse
F09	Fen Palsa
F10	Fen Spring
F11	Fen Slope
F12	Fen Lowland Polygon
F13	Fen Horizontal
F14	Fen Channel
S01	Swamp Stream
S02	Swamp Shore
S03	Swamp Peat Margin
S04	Swamp Basin
S05	Swamp Flat
S06	Swamp Floodplain
S07	Swamp Spring
M01	Marsh Estuarine High
M02	Marsh Estuarine Low
M03	Marsh Coastal High
M04	Marsh Coastal Low
M05	Marsh Floodplain
M06	Marsh Stream
M07	Marsh Channel
M08	Marsh Active Delta
M09	Marsh Inactive Delta
M10	Marsh Terminal Basin
M11	Marsh Shallow Basin
M12	Marsh Kettle
M13	Marsh Seepage Track
M14	Marsh Shore

5. SLOPE GRADIANT CLASSES
(Col. 17; Col.33; Col. 56; Col. 64; Col. 68)

a 0-3%
b 4-9%
c 10-15%
d 16-30%

6. POLYGON NUMBER
(Cols. 19-22)

7. GENETIC PARENT MATERIAL
(Cols. 23-24; Cols. 46-47)

A Alluvial
C Colluvial
E Eolian
F Fluvioglacial
L Lacustrine
M Morainal
W Marine
U Undifferentiated

(Col. 18)

11 Fibric Spagnum
21 Mesic Sedge
22 Mesic Woody Sedge
23 Mesic Woody Forest
24 Mesic Brown Moss
31 Humic Sedge
32 Humic Woody Sedge
33 Humic Woody Forest
34 Humic Brown Moss

8. SOIL TEXTURE OF SURFACE AND PARENT MATERIAL
(Cols. 25-28; Cols. 34-37; cols. 48-51; cols. 57-60

S Sand
LS Loamy sand
FS Fine sand
GS Gravelly sand
CB Cobbly

SL Sandy loam
FL Fine sandy loam
GSL Gravelly sandy loam
GL Gravelly loam
L Loam
GSIL Gravelly silt loam
VL Very fine sandy loam
SIL Silt loam

VCL Very fine sand clay loam
CL Clay loam
SICL Silty clay loam

SC Sandy clay
SIC Silty clay
C Clay
HC Heavy clay

9. AVAILABLE WATER CAPACITY CLASSES
(Col. 38)

1 50 mm
2 100 mm
3 150 mm
4 200 mm
5 250 mm
6 Not applicable (Solonetzic soils)
7 Not applicable (Soils with high water table)

10. CALCAREOUS CLASSES
(Col. 39)

1 Weakly
2 Strongly
3 Extremely

11. WATER TABLE DEPTH
(Col. 40)

1 0-2m
2 2-3m
3 more than 3 m

12. SOILS INCLUSIONS
(Cols. 41-42; Cols. 43-44)

A Acid surface soils (pH less than 6.0)
BS Bedrock soft
BR Bedrock hard
CA Calcareous surface soil
C Clay substrate
E Eroded knolls
GL Gleyed
ID Imperfectly drained
MP Moss peat
O Organic
PD Poorly drained
PP Poorly drained, peaty
SA Saline
ST Stoney
T Till substrate
WE Wind erosion
WD Well drained

13. REGIONAL LANDFORMS (Col. 45; Col. 65; Col. 70)

P Plains
H Hillands
B Bedrock uplands (or Tablelands, or Plateau)
V Glacial valleys
D Bedrock valleys
S Scarps
M Mountains or Alpine Peaks

14. NON SOIL MATERIALS - WHEN DOMINANT (Cols. 61-62)

R1 Soft rock undifferentiated
R2 Hard rock acid
R3 Hard rock carbonaceous
R4 Hard rock undifferentiated

LOCAL SURFACE FORM (Col. 63) - (See Col. 17)
SLOPE CLASS (Col. 64) - (See Col. 18)
REGIONAL FORM (Col. 65 - (See Col. 45)

NON SOIL MATERIALS - WHEN SUBDOMINANT (Col. 66-67)

R1 Soft rock undifferentiated
R2 Hard rock acid
R3 Hard rock carbonaceous
R4 hard rock undifferentiated

Local surface form (Col. 68)
Slope class (Col. 69)
Regional Form (Col. 70)

15. DOMINANT DRAINAGE (Col. 71)

W Well
I Imperfect
P Poor

SUBDOMINANT DRAINAGE (Col. 72)

W Well
I Imperfect
P Poor

16. SOIL CAPABILITY CLASSES (Cols. 1-6)

Guidelines

A. A maximum of 3 Classes (and their Subclasses) are permitted.

B. Four combinations of Classes are permitted as follows:

(a) 100% one Class and Subclass
(b) 80% one Class and Subclass; 20% of another Class
(c) 60% one Class and Subclass; 40% of another Class
(d) 50% one Class and Subclass; 30% of another Class; 20% of third Class.

17. LAND USE CLASSES (from Wildlife or CLI Maps)

(Col. 7)
1. 0-10% Cultivated
2. 10-50% Cultivated
3. 50-70% Cultivated
4. 70-90% Cultivated
5. 90-100% Cultivated

KIND OF NATIVE VEGETATION

(Col. 8)
G Grassland
W Woodland
M Mixed Grassland-Woodland

Table 4. PERMANENT WATER BODY PROPERTIES OBSERVABLE FROM LANDSAT (AFTER TARNOCAI AND COLLEAGUES)

1. DIFFERENTIATING PROPERTIES

1.1 KINDS OF WATER BODIES

L - LAKES
R - RIVERS AND STREAMS

1.2 PERCENT OCCUPANCE OF POLYGON

CLASS 1 - 5%
CLASS 2 - 5-10%
CLASS 3 - 10-20%
CLASS 4 - 20-35%
CLASS 5 - 35-50%

2. DESCRIPTIVE PROPERTIES

2.1 SIZE

SMALL (1 KM^2)
MEDIUM (1-10 KM^2)
LARGE (11-50 KM^2)
VERY LARGE (50 KM^2)

2.2 NUMBER PER UNIT AREA OF 2500 KM^2
(APPROX. 5 CM X 5 CM AT SCALE 1:1 MILLION)

VERY FEW (1)
FEW (2-5)
COMMON (6-15)
MANY (16-50)
ABUNDANT (51)

Table 5. Example of publication legend (closed format)

(A) BROWN CHERNOZEMIC SOILS DEVELOPED ON:

	Texture[1] Group	Genetic Material	Surface Form[2] and Slope Class[3]	
fA	Sandy loam	Glaciofluvial	Hb (Hummocky	4-9%)
			Kc (Knoll and Kettle	10-15%)
			Ua (Undulating	0-3%)
			Ub (Undulating	4-9%)
lA	Loam	Lacustrine	Db (Dissected	4-9%)
			Hb (Hummocky	4-9%)
			Kd (Knoll and Kettle	15-30%)
			Ua (Undulating	0-3%)
mA	Loam	Morainal	Db (Dissected	4-9%)
			Dc (Dissected	10-15%)
			Hb (Hummocky	4-9%)
			Hd (Hummocky	15-30%)
			Kb (Knoll and Kettle	4-9%)
			Kc (Knoll and Kettle	10-15%)
			Kd (Knoll and Kettle	16-30%)
			Mb (Rolling	4-9%)
nA	Loam	Eolian	Db (Dissected	4-9%)
rA	Clay Loam	Lacustrine	Hb (Hummocky	4-9%)
sA	Clay Loam	Morainal	Db (Dissected	4-9%)
			Dc (Dissected	10-15%)
			Dd (Dissected	10-15%)
			Hb (Hummocky	4-9%)
			Hc (Hummocky	10-15%)
			Hd (Hummocky	16-30%)
			Kb (Knoll and Kettle	4-9%)
			Kc (Knoll and Kettle	10-15%)
			Kd (Knoll and Kettle	16-30%)
			Mb (Rolling	4-9%)
			Ua (Undulating	0-3%)
			Ub (Undulating	4-9%)
vA	Clay	Lacustrine	Hb (Hummocky	4-9%)
			Ua (Undulating	0-3%)
			Ub (Undulating	4-9%)

(B) DARK BROWN CHERNOZEMIC SOILS DEVELOPED ON:

fB	Sandy loam	Glaciofluvial	Hb (Hummocky	4-9%)
			Ua (Undulating	0-3%)
gB	Sandy loam	Morainal	Kc (Knoll and Kettle	10-15%)
lB	Loam	Lacustrine	Kb (Knoll and Kettle	4-9%)
			Ua (Undulating	0-3%)
mB	Loam	Morainal	Db (Dissected	4-9%)
			Hb (Hummocky	4-9%)
			Hc (Hummocky	10-15%)
			Kb (Knoll and Kettle	4-9%)
			Kc (Knoll and Kettle	10-15%)
			Kd (Knoll and Kettle	16-30%)
			Ua (Undulating	0-3%)

Table 5. (continued)

(R) REGOSOLIC SOILS DEVELOPED ON:

cR	Sand	Eolian	Hb (Hummocky	4-9%)
			Hc (Hummocky	10-15%)
			Hd (Hummocky	16-30%)
			Ua (Undulating	0-3%)
uR	Clay Loam	Fluvial	Ua (Undulating	0-3%)
yR	Clay	Fluvial	La (Level	0-3%)
			Ua (Undulating	0-3%)
zR	Loam	Undifferentiated	Da (Dissected	0-3%)
			Db (Dissected	4-9%)
			Dd (Dissected	16-30%)

(U) GLEYSOLIC SOILS DEVELOPED ON:

sU	Clay loam	Morainal	La (Level	0-3%)
yU	Clay	Fluvial	La (Level	0-3%)

(X) ORGANIC FIBRISOLS DEVELOPED ON:

11	Fibric Sphagnum B04 (Bog Domed)

(Y) ORGANIC MESISOLS DEVELOPED ON:

21	Mesic Sedge F13 (Fen Horizontal)
22	Mesic Woody Sedge
23	Mesic Woody Forest

FOOTNOTES:

1 Texture Groups:
Sand or Gravel or Loamy sand;
Sandy loam or Fine sandy loam or Gravelly sandy loam;
Loam or Very fine sandy loam or silt loam;
Clay loam or Very fine sandy loam or silty clay loam;
Clay or silty clay oir Heavy clay.

2 SURFACE FORMS:
D - Dissected or gullied pattern providing external drainage for an area;
H - Hummocky pattern with chaotic sequence of pronounced knolls and swales;
K - Hummocky pattern with chaotic sequence of knolls and numerous kettles (or sloughs) which occupy 15-20% of an area;
L - Level or nearly flat featureless pattern;
M - Rolling pattern with a regular sequence of long, moderate slopes rising to broad rounded convexities;
R - Ridged pattern with a sequence of long narrow sharp crested ridges and accompanying swates;
U - Undulating pattern with a regular sequence of gentle slopes.

3 Slope Gradiant Classes
a - 0 to 3%
b - 4 to 9%
c - 10 to 15%
d - 16 to 30%

Table 6. Example of publication legend (closed "axial" format)

(A) BROWN CHERNOZEMIC SOILS DEVELOPED ON:

Genetic Material	Texture[1] Group	Color and Map Symbol	Surface form[2] and Slope Class[3]	
Glaciofluvial	Sandy loam	fA Hb	(Hummocky	4-9%)
		fA Kc	(Knoll and Kettle	10-15%)
		fA Ua	(Undulating	0-3%)
		fA Ub	(Undulating	4-9%)
Lacustrine	Loam	la Db	(Dissected	4-9%)
		lA Hb	(Hummocky	4-9%)
		lA Kd	(Knoll and Kettle	16-30%)
		lA Ua	(Undulating	4-9%)
Morainal	Loam	mA Db	(Dissected	4-9%)
		mA Dc	(Dissected	10-15%)
		mA Hb	(Hummocky	4-9%)
		mA Hd	(Hummocky	15-30%)
		mA Kb	(Knoll and Kettle	4-9%)
		mA Kc	(Knoll and Kettle	10-15%)
		mA Kd	(Knoll and Kettle	16-30%)
		mA Mb	(Rolling	4-9%)
Eolian	Loam	nA Db	(Dissected	4-9%)
Lacustrine	Clay Loam	rA Hb	(Hummocky	4-9%)
Morainal	Clay Loam	sA Db	(Dissected	4-9%)
		sA Dc	(Dissected	10-15%)
		sA Dd	(Dissected	10-15%)
		sA Hb	(Hummocky	4-9%)
		sA Hc	(Hummocky	10-15%)
		sA Hd	(Hummocky	16-30%)
		sA Kb	(Knoll and Kettle	4-9%)
		sA Kc	(Knoll and Kettle	10-15%)
		sA Kd	(Knoll and Kettle	16-30%)
		sA Mb	(Rolling	4-9%)
		sA Ua	(Undulating	0-3%)
		sA Ub	(Undulating	4-9%)
Lacustrine	Clay	vA Hb	(Hummocky	4-9%)
		vA Ua	(Undulating	0-3%)
		vA Ub	(Undulating	4-9%)

(B) DARK BROWN CHERNOZEMIC SOILS DEVELOPED ON:

Genetic Material	Texture Group	Color and Map Symbol	Surface form and Slope Class	
Glaciofluvial	Sandy Loam	fB Hb	(Hummocky	4-9%)
		fB Ua	(Undulating	0-3%)
Morainal	Sandy Loam	gB Kc	(Knoll and Kettle	10-15%)
Lacustrine	Loam	lB Kb	(Knoll and Kettle	4-9%)
		lB Ua	(Undulating	0-3%)
Morainal	Loam	mB Db	(Dissected	4-9%)
		mB Hb	(Hummocky	4-9%)
		mB Hc	(Hummocky	10-15%)
		mB Kb	(Knoll and Kettle	4-9%)
		mB Kc	(Knoll and Kettle	10-15%)
		mB Kd	(Knoll and Kettle	16-30%)
		mB Ua	(Undulating	0-3%)

Table 6. (continued)

(R) REGOSOLIC SOILS DEVELOPED ON:

Eolian	Sand	cR Hb	(Hummocky	4-9%)
		cR Hc	(Hummocky	10-15%)
		cR Hd	(Hummocky	16-30%)
		cR Ua	(Undulating	0-3%)
Fluvial	Clay Loam	uR Ua	(Undulating	0-3%)
Fluvial	Clay	yR La	(Level	0-3%)
		yR Ua	(Undulating	0-3%)
Undifferentiated	Loam	zR Da	(Dissected	0-3%)
		zR Db	(Dissected	4-9%)
		zR Dd	(Dissected	16-30%)

(U) GLEYSOLIC SOILS DEVELOPED ON:

Morainal	Clay Loam	sU La	(Level	0-3%)
Fluvial	Clay	yU La	(Level	0-3%)

(X) ORGANIC FIBRISOLS DEVELOPED ON:

11 Fibric Sphagnum B04 (Bog Domed)

(Y) ORGANIC MESISOLS DEVELOPED ON:

21 Mesic Sedge F13 (Fen Horizontal)
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Sand or Gravel or Loamy sand;
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Clay loam or Very fine sandy loam or silty clay loam;
Clay or silty clay oir Heavy clay.

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D - Dissected or gullied pattern providing external drainage for an area;
H - Hummocky pattern with chaotic sequence of pronounced knolls and swales;
K - Hummocky pattern with chaotic sequence of knolls and numerous kettles (or sloughs) which occupy 15-20% of an area;
L - Level or nearly flat featureless pattern;
M - Rolling pattern with a regular sequence of long, moderate slopes rising to broad rounded convexities;
R - Ridged pattern with a sequence of long narrow sharp crested ridges and accompanying swates;
U - Undulating pattern with a regular sequence of gentle slopes.

3 Slope Gradiant Classes
a - 0 to 3%
b - 4 to 9%
c - 10 to 15%
d - 16 to 30%

Soil Survey Handbook

G.M. Coen

At the 1981 meeting of the Expert Committee on Soil Survey an editorial lead committee was established under the Correlation Working Group to consider the preparation of a Soil Survey Procedures Handbook. The editorial lead committee was to determine the content of the Soil Survey Procedures Handbook (see also terms of reference, E.C.S.S. 3rd Meeting 1981, pp. 172, 173).

At the 1982 meetings, the editorial lead committee reached a concensus to test over the next year, the following specific proposals:

1. Statement of objectives; the Soil Survey Handbook records the procedures by which soil surveys are established, the guidelines by which they are evaluated and guidelines to assist in information transfer.

2. Outline; the outline accompanying this report should be used as the framework in building the handbook.

3. Style; the writing style and information content should be appropriate to serve practicing soil surveyors (a portion of section 400 has been written and was circulated as an example).

4. Organization; the materials should be duplicated on both sides of 8 1/2 x 11 inch pages with holes for 3 ring binder. The writing style and chapter headings should allow easy addition, deletion or modification of sections (when sufficient agreement is reached so that the manual could be expected to remain relatively static for a 3-5 year period it may be desirable to publish parts as a printed document for use by a broader audience).

The recommendations made at the 1981 Expert Committee of Soil Survey Meetings have been addressed, namely:

1. The ECSS has undertaken the compilation of a Soil Survey Manual.

2. The compilation of an outline, a portion of section 400 and the designation of potential Section editors (these people will be contacted as to their availability to assist with the project).

3. Most of the persons appointed to editorial functions to date were able to travel to the 1982 meetings.

Recommendations from the 1982 meetings are:

1. The editorial lead committee should approach potential Section editors to ascertain their availability to undertake editorial duties.

2. The editorial lead committee should assist the designated Section leaders to obtain authors for various topics.

3. The preparation of the manual should proceed as quickly as the availability of personnel will allow.

A copy of the proposed Introduction and outline are included to give an idea of the current concepts for the Soil Survey Handbook. Comments on the proposed outline or other topics by interested persons are welcomed, and should be addressed to Gerald Coen, Alberta Soil Survey Unit, Agriculture Canada Soil Survey Terrace Plaza Tower, 4445 Calgary Trail South, Edmonton, Alberta. T6H 2C3.

INTRODUCTION

The purpose of the Soil Survey Handbook is to provide procedures for and thereby facilitate precise and efficient soil survey programs in Canada. It is organized into seven sections as follows:

- 100 Soil Surveys in Canada
- 200 Planning for Soil Surveys
- 300 Managing Soil Survey Operations
- 400 Conducting Soil Surveys
- 500 Application of Soil Survey Information
- 600 Soil Survey Investigations
- 700 Information and Display Systems

Section 100 provides an overview of how the undertaking of soil surveys in Canada is presently organized. It includes the nature of the Federal-Provincial agreements and understandings as well as the Private Sector Contribution to the overall soil survey program.

Section 200 describes how priorities for soil surveys are established at the national, provincial and local levels, and then how these separate priorities are reconciled. The agencies involved in this process includes the *Expert Committee on Soil Survey* (ECSS), the *Canada Committee on Land Resource Services*

(CCLRS), the *Canadian Agricultural Research Council* (CARC) and the *Canadian Agricultural Services Coordinating Committee* (CASCC). At the provincial level the *Provincial Soil Advisory Committees* and the *Institutes of Pedology* also become involved in this overall planning process.

Section 300 provides a discussion of the decisions that must be made at the level of *Unit Heads of Soil Surveys* within the Provinces. This section provides the criteria needed to establish the appropriate Survey Intensity Level (SIL) for a given project so that the final maps and reports will contain the information identified as necessary when the decision was made to undertake the survey. Included in this section is a discussion of the things to consider when setting up cooperative agreements for the inventory and for designating the *Project Leader*.

Section 400 encompasses procedures to assure quality control throughout the project. Elements of an appropriate detailed plan are discussed and guides are provided to assist in assembling and assessing existing resource information. Also included is a discussion of the procedures available to assess the precision, accuracy, and appropriateness of the maps and data.

Section 500 provides guidelines for making interpretations of soil survey maps. Also included is information about computerized interpretation procedures and computer produced extractive maps.

Section 600 provides guidelines for identifying the laboratory analysis and both laboratory and field special study requirements associated with specific soil survey projects.

Section 700 provides guidelines to assist in effective "Information Transfer" of soil survey information from the mapping team to the identified audience. This includes a discussion of the format of soil survey reports and other publications. The need for and the uses of the many technical documents prepared for the use of soil surveyors and associated scientists is also explored. Also the various computer assisted reports that facilitate the "Information Transfer" process are described.

SOIL SURVEY HANDBOOK
SECTION 400
CONDUCTING SOIL SURVEYS

401 DETAILED PLAN FOR THE SURVEY PROJECT AREA

Earlier in the planning process the general objectives of the survey will have been identified, the prime user identified and the funding established. The objective at this point is to undertake detailed planning, well in advance of the field mapping, to ensure that personnel and equipment are assembled to achieve the aims of the project and to assure that the funding available matches the anticipated costs to achieve the agreed upon products.

Where in Handbook

Requires a statement that this entire section is prepared to explain the Project Plan and assist in its documentation. It is desirable that this section be organized in the same sequence as the Project plan *

401.1 Project Specification

The project specifications as identified by the agreement which initiated the project (see section 300) should be examined by the Party Leader and if necessary more explicitly described so that the data collected will satisfy the objectives of the survey. The following items should be explicitly defined.

Project Plan ?

(a) Description of the area to be surveyed. The survey area may be described by National Topographic Series Notation or Political boundaries when the maps area coincides with these

401.1(a)

boundaries. For other areas a sketch map may be necessary to define the boundaries (A5 of Project Plan). The size of the area to be mapped should be provided in ha or km^2, also the area of water bodies greater than 20 ha in extent or of rivers, greater than 0.2 km wide.

(b) Purposes of the survey. The principal purpose of the survey should be described to assure that the survey team is familiar with the kinds of information that is likely to be needed. Most surveys will be of a multiple purpose nature because the incremental cost of recording extra information above the needs of the principal purpose is very small compared to the cost of a resurvey for another principal purpose. Thus, experience and judgement are necessary on the part of the Party Leader (B3 of Project Plan).

If the survey area is being wholly or partially remapped, describe what the revised or updated survey will provide that the old one did not and why it is needed.

(c) Cooperating agencies. The cooperating agencies and their respective contributions, both in terms of funding and

401.1(c)
personnel should be recorded. A clear understanding of the cooperative arrangements and of the responsibility for leadership is necessary to assure the orderly operation of the inventory program (C1-C5 of Project Plan).

(d) Mapping specifications. Guidelines for designing map units and determing their composition should be provided (ECSS 1981). The minimum size of map unit delineations, Survey Intensity Level and inspection density should be specified in order to assure that the required soil parameters are cartographically separated. The required soil parameter classes (wetness, texture, stoniness, slope) are dictated by the anticipated interpretations (F2 and F3 of Project Plan). NB

(e) Interpretations. Soil surveys record a broad spectrum of soil characteristics only a portion of which may be necessary for a given land management decision. Interpretations are a necessary part of every soil survey because they answer the questions posed by the purposes of the survey. The major interpretations to be made and the individuals or agencies responsible should be specified. Special studies needed to

(f) Staff. The number, and names, if possible, of soil scientists and others who will be assigned to the survey, and the agency employing each should be listed. The name and agency of the Party Leader should be given (more than anyone else the Party Leader is responsible for the quality and efficiency of the soil survey). Here also should be identified the need for assistance from specialists from other disciplines and agencies (eg. hydrologists, geologists, ecologists, crop specialists) and if possible suggest the names or sources of this assistance. An estimate should be made of the amount of time that the Provincial and Federal Correlators will need to contribute to the project (D1 and D2 of Project Plan).

(g) Equipment. Special equipment that may be needed and a source for obtaining it as well as specialized transportation requirements should be described. Tools, equipment and supplies that are routinely used on soil surveys need not be listed here (D3 and D4 of Project Plan).

(h) Kind of mapping base for field work and publication. The kind of mapping base to be used (aerial photographs, topographic maps, or others) for both field work and for publication should be specified. The base chosen for publication should satisfy the needs of the prime user, and be as useful as possible for a wide variety of other users and yet be as economical as possible. A satisfactory mapping base for both field work and/or publication is selected at this stage and that selection should not change during the survey. Poor mapping bases increase field costs. The base for field work should be the same scale as the publication base. The scale must suit the survey intensity level. A scale that is too large, or a change in scale after mapping has started, greatly increases both field and publications costs. Refer to *A Soil Mapping System for Canada* (ECSS 1981) and E3 of Project plan.

(i) Laboratory analyses and special studies. The need for and source of routine and special laboratory analyses should be specified. Special studies required to properly characterize the map units or support the interpretations (see (e) above) should, if possible, be planned at the beginning of the survey (E6 of Project Plan).

(j) Publication plans. Plans for publication of the reports and maps should be specified. Specify the scale of the final soil maps and of the generalized soil map (if present). Will the maps be digitized? Will the maps be published in color, black and white, colored base and black soil lines, or on a black and white photo base or a one color photo base with black soil lines? The map publication format can affect the legend format, as well as the design of mapping units. Will the report be illustrated with photos and/or cross section or block diagrams. Must the report be illustrated with color photos? Will portions of the report and/or maps be published on microfiche? These decisions influence the assignment of duties to be sure that proper illustrative material is obtained and that funding is available to print the report (E11 of Project Plan).

(k) Schedule. A schedule should be prepared that will identify key dates associated with the Progress of the survey. such dates should include, but not be restricted to, the starting date of field work, the date field work will be completed, the date the bases will be required for field work and the final map, the date the manuscript maps will be ready for drafting (and digitizing) and the date the text manuscript will be available for editing. An estimated publication date should be provided.

401.1(1)

(1) Other items. The availability of suitable aerial photographs should be assessed. Also the availability and applicability of reference materials about soils, relief, geology and vegetation should be assessed.

Once all of the project specifications have been reviewed and finalized a budget should be prepared. The predicted cost of the soil survey should match the funds available as specified in the preliminary planning (section 300). If the predicted costs do not match the funds available the party leader should ensure that the planning and contract negotiation team reevaluate either the funds available or the general objectives of the survey. The prime user may want more information than he is willing to pay for or it may be necessary to meet the requirements of fewer secondary users. Once the project plan is finalized and adopted the project can be initiated.

402 ASSEMBLY OF RESOURCE INFORMATION

Well ahead of the initiation of mapping it is necessary to assemble the existing resource information and evaluate the adequacy of this information. This timely assessment allows for ordering the flying of new photography, preparation of appropriate base maps or arranging for expert assistance in complimentary resource fields.

402.1 Cultural And Land Use Information

Maps and reports of various kinds are frequently available and useful in preparing for and conducting a soil survey. Small scale highway maps distributed by Provincial Departments of Tourism emphasize major transportation routes. County land ownership maps are frequently useful in obtaining permission to examine the soils. Aeronautical charts emphasize ground features which are prominent from the air, and may be useful as base maps for plotting aerial photograph flight lines, or for a quick overview of the survey area. County or regional planning maps and reports frequently provide natural resource and cultural information useful in conducting the soil survey. Topographic maps, published by the Surveys and Mapping Branch, Department of Energy, Mines and Resources at various scales are the source of relief information and frequently provide accurate base information.

402.2 Aerial Photographs, Mosaics, other Imagery

All available aerial photography should be evaluated in relation to both mapping in the field and for the preparation of base maps for publication. Sets of photographs of an area taken over a period of years are valuable references for evaluating soil patterns under different vegetation and soil conditions. Generally, using older photography as the mapping base is expensive, even if the quality and scale are satisfactory. The changes in land use and associated problems often either require the mapping to be transferred to a more recent photo base or cause problems in transfering to a recent planimetric base. Mosaics that may have been prepared for the area as well as high altitude and satellite imagery, should be investigated for their applicability to the proposed soil survey. This information assembled well ahead of the initiation of the inventory allows field programs to be well planned and assures that they will not be impeded because of a lack of available information.

402.3 Natural Resource Information

Soil surveys, ecological, climatological, hydrological, and forest cover or ecological maps of the area should be assembled and assessed. Soil map units and other natural resource information are frequently related to the landscape and to each other in a predictable fashion. Thus, a knowledge of the existing natural resource information is very useful in developing preliminary legends as well as in facilitating the routine mapping. Because of the nature of the interpretations desired for the map area it may be necessary to have specific natural resource information from a related discipline. This information may be available in existing reports, and if not, it will have to be obtained by alternate means.

402.4 Requirements to Fill Perceived Gaps

(a) Aerial photographs. Copies of useful aerial photographs should be obtained as well as copies of mosaics and/or satellite imagery. If existing flight lines of photographs are unsatisfactory for use as either field mapping or publication bases, contracts to obtain a new flight of photographs should be prepared and awarded at least two years before initiation of the field mapping. Specifications for the new flight should be carefully prepared so that the resulting photographs are of maximum utility. It is frequently cheaper to obtain a new flight of photographs than to work with an inferior existing flight.

(b) Base maps. Base maps should be ordered well ahead of the anticipated publication date. If aerial photographs are to be used as the base for the published maps, considerable preparation such as rectification, density of image adjustment, arrangement into page (or publishing) size images, etc., is required. If topographic maps are to be used as base

402.4(b)
maps there is frequently considerable preparation required. National Topographic Series maps can be obtained from Energy, Mines and Resources on stable base material and in several components, such as cultural features, separate from topographic lines or from lakes and rivers depending somewhat on the map area involved. Frequently, two or more NTS maps must be joined to provide a base for a county or other political area. This joining requires additions and deletions of names, legends, and frequently changes in symbols on one or more of the joined sheets. Occasionally a suitable base must be prepared by modifying and compositing otherwise unsuitable bases. Since the accuracy of the soil survey information on the published map is the responsibility of the party leader, the base map should be available so that the mapping is either done on the base information or transferred to it on an ongoing basis.

(c) **Contract information.** Prior to initiating the field program required information that will not be obtained by the survey team should be identified. If this information is to be obtained by contracting to another agency, the terms of the contract should be prepared, possible suppliers of the information identified, and the contract awarded to assure timely incorporation of the data into the soil survey data set.

403 ALLOCATION OF DUTIES

The allocation of duties to positions assures that all aspects of the survey are efficiently handled and that some duties are not inadvertently overlooked. A party leader is in charge of the survey and should have both the responsibility and authority to see that all aspects of the survey are properly carried out. Other scientists are assigned as needed to accomplish the survey according to the project plan.

Quality and efficiency of soil surveys are usually increased if the same soil scientists complete the work within a few years. Over a short time span, concepts and procedures can be kept consistent and a map of uniform quality can be produced. Also a single party leader usually can direct the entire survey, and few or no changes will be made in the staff. It does not matter how meticulous data recording procedures are, when a staff member leaves a project he takes some useful information about the survey area with him.

403.1 Party leader

The party leader is responsible for supervising field work and keeping its quality high. He must continually test the mapping legend so that it is consistent throughout the area and fulfills the requirements set out in the project plan. The mapping and legend testing must be done in the field. The party leader works with other members of the field party to solve the problems they encounter in mapping.

As mapping progresses, the party leader reviews the field work of the field party for uniformity of detail, consistency of soil identification, accuracy of soil boundaries, and cartographic legibility. He determines that the delineations are adequate for the objectives and that they do not contain unneeded detail. He reviews samples of mapping done by each member of the party and, with them, decides what adjustments are needed.

The party leader commonly trains some of the field staff, thereby contributing to the quality of mapping. Inexperienced soil scientists must be trained. A beginning soil scientist does not have the skill necessary for independent mapping, and this skill must be developed. As new people gain experience, continued field checks of their mapping are needed. Experienced workers from other areas must learn the soil relationships in the survey area.

The party leader must see that the field sheets are legible, complete, and joined. He is usually responsible for writing much of the text and assembling the manuscript for the published soil survey, although others, both soil scientists and specialists in other disciplines, may supply field notes and may write various sections of the manuscript under the party leader's direction. The party leader has the major responsibility for interpretations of the soils, though specialists in other disciplines contribute important parts.

The party leader is, in fact, the first and foremost contributor to the correlation process. He prepares the documentation for the appropriate levels of correlation, arranges for field reviews supported by documentation of problems, and checks the uniqueness and appropriateness of the classification of the map units. After consultation with the Provincial correlator assigned to help the project, the party leader should set the date and initiate the appropriate level of field review, and ensure that the decisions taken during the review are fully recorded, and fully implemented.

403.2 Mappers

The number of persons needed for a soil survey depends on many factors. Scheduling of the work and the projected date of completion dictate input of personnel over a specified period of time. Factors such as the complexity of the soil patterns, the kind of survey and the refinement of map units required for its objectives, the accessibility of the areas to be mapped and the ease or difficulty with which they can be traversed, and the experience and proficiency of mappers determine the rate of progress. Characterization and interpretation of soil, assembly of field notes, and preparation of manuscript maps and texts for publication also require personnel and time. The cooperating agencies must either provide the personnel needed to complete the work by the specified time or adjust the projected date of completion to the personnel available.

The abilities of workers are important factors. Since an inexperienced worker can at first do only a limited amount of mapping of acceptable quality and because an experienced soil scientist's time is required for training the new worker, the net accomplishment is usually very small for the first six months of the new person's time. Time must be allowed for even experienced surveyors to learn the relationships among soils and landscapes in a new area, especially if their experience has been in different environments. Activities other than mapping also require special skills and knowledge that are acquired through experience as well as training.

The stamina of workers is an important consideration. Fieldwork is physically demanding. In areas of rugged relief or dense vegetation only those who are in good physical condition can work efficiently.

The party leader must access the assembled staff and assign duties in such a way that all aspects of the survey are properly completed within the alloted time and the talents and aspirations of the staff are used to best advantage.

403.3 Student Assistants and Casual Employees

Surveys can be accelerated by the judicious use of student assistants. Driving vehicles and digging holes has been a traditional contribution of student assistants. Assistance with sampling and sample preparation, inking field maps, tabulating data and assorted duties also provide a valuable contribution to the survey. In fact many soil surveyers have gained their first survey experience employed as student assistants. After an initial training period many student assistants and technicians are able to contribute in a meaningful way to the mapping portion of the program.

403.4 Laboratory Analysts

Survey units commonly have either one or more laboratory analysts or access to a service laboratory. When allocating duties it is

403.4
necessary to assess whether the analytical requirements of the project can be met by the existing staff in time to meet the project deadlines. If not, then arrangements must be made to obtain the additional assistance that is required. This can frequently be done by hiring student assistants (see 403.3) above). One of the problems that a party leader frequently faces is obtaining laboratory data quickly in order to verify map unit judgements, or to write the manuscript. Early identification of the need for additional assistance may help alleviate this problem.

403.5 Draftspersons

Survey units commonly have either a draftsperson or access to drafting services. When allocating duties it is necessary to assess whether the drafting requirements of the project can be met by the existing services in time to meet the project deadlines. If not then arrangements must be made to obtain the additional assistance that is required. This can frequently be done by hiring student assistants or casual employees, depending upon the nature of the additional assistance (see 403.3 above). By careful planning for drafting services it should be possible to avoid having soil mappers undertake jobs better done by draftspersons.

403.6 Correlators

Correlation is necessary to maintain high quality throughout the progress of the soil survey. The party leader is responsible for the initial correlation activities of the project. A provincial correlator should be named as responsible to provide assistance to the party leader and to assure that consistent standards are adhered to from project to project within a province. At the request of the party leader mutually agreeable arrangements should be made for conducting the appropriate field and project reviews. Some of the decisions likely to be made in the field review are interprovincial or national in scope. Thus the provincial correlator should notify the appropriate national correlator and if desirable arrange for the national correlator to attend the field and project review. The provincial correlator should edit the recorded results of the field and project review and verify that they reflect the results of the discussions. He should also send copies of the field review records to the national correlator.

403.7 Special Investigations Cooperators

The purpose of the soil survey may necessitate special studies that fall outside the expertise or jurisdiction of the survey team. Sometimes these studies may be undertaken by a contract (see 402.4(c)). In other instances the special studies may be of mutual interest with another agency or group. An agreement as to the nature of the contribution of the soil survey team and of the cooperator should be prepared in writing in order to ensure a clear understanding of commitments and deadlines on the part of both parties even though there may be changes in staff or administrators.

404 Standards for Soil Classification, Mapping and Quality Control

Standards and procedures for describing soils and for soil classification are set out in *The Canadian System of Soil Classification* (CSSC 1978a) and *The Manual For Describing Soils in The Field* (CSSC 1978b). Accuracy of classification and mapping frequently is dependent on sampling and laboratory analysis. Guidelines are provided by *The Manual on Soil Sampling and Methods of Analysis* (CSSC 1978c). Standards and guidelines for soil mapping procedures are provided by *A Soil Mapping System for Canada* (ECSS 1981). The following sections deal with the use of these publications for maintaining quality control and provides further guidelines where necessary.

404.1 Soil Taxonomy

The Canadian system of soil classification organizes knowledge about sets of soil properties and concepts about interrelationships among the sets. It identifies sets of properties and groups them in taxonomic classes. Using the soil taxonomy to identify and name soils provides an efficient and precise way to summarize many scientific and interpretive facts about that soil. Because a soil taxonomy is, at any point in time, a model of our understanding of interrelationships between sets of soil properties, when new information invalidates the model then the taxonomy must be modified accordingly. The system is dynamic, and must be updated at intervals.

(a) Form and Content. The national system of soil classification consists of both the definitions and descriptions above the series level as presented in the Canadian system of soil classification plus the definitions of the individual series, including their limits, that are used in soil survey reports throughout Canada. Soil series descriptions are in various stages of completeness throughout Canada, depending somewhat upon the province and the project where the series is currently being used. To complete the Canadian system of soil classification a comprehensive set of series descriptions are necessary.

404.1(b)

b) Use and Application to Soil Surveys

(1) General. Surveys require that map units be related to real bodies of soil in such a way that practical soil groupings are easily prepared and that comparisons of similarities and differences between tha real bodies of soil are readily undertaken for a wide variety of purposes. The classes at the lowest category of the Candadian system of soil classification (series) are sufficiently homogeneous that they can be regrouped to provide the many different special interpretive groupings that are frequently needed to fulfill the objectives of the survey. At higher categorical levels the soil classification provides inferences useful to groupings made for relatively large areas on small scale maps. *The Canadian system of soil classification* is the standard reference for organizing and transferring knowledge about soils. It is a common base to which special, practical soil groupings can be related. In soil surveys, the soil classification system is used to provide:

- A means of remembering selected properties of soils, because the names of the higher categories are connotative to those familiar with the nomenclature.

- A means for understanding the relationships among soils within a given area and among soils of different areas.

- A means of projecting experience with a kind of soil in one area to a similar kind of soil in another area.

- Names that can be used as reference terms to identify soil mapping units.

2) Relationships Between Soil Taxa and Mapping Units. Pages 31 to 34 in *A Soil Mapping System for Canada* (ECSS 1981) and Chapter 19 of *Soil Taxonomy* (Soil survey Staff 1975) provide excellent discussions concerning the relations between soil taxonomy and soil survey. This section provides a brief summary of this subject. The names of soil taxa are used as reference terms in naming mapping units.[1] Soil taxa are classes at any categorical level in the multicategorical system of soil taxonomy. The name used is that of a taxon which best

1 Series are normally given geographic names associated with the vicinity where the soil was first described, or where the typifying pedon is located. In recent years some soil surveys have identified mapping units using the same convention but have not described or established series to correspond to the new name. This results in some ambiguity in the naming of mapping units.

404.1(b)(2)
identifies the set(s) of soil properties that the map is designed to portray. Even though map units are identified by the names of one or more taxonomic classes, the mapping units are not the same as soil taxa. When the fixed limits of soil taxa are superimposed on the fixed pattern of soils in nature, limits of taxonomic classes rarely, if ever, coincide precisely with mappable areas. A mapping unit name is frequently distinguished from a soil taxon name by adding one or more phase terms (eg. slope) to the soil taxon reference name.

The classes described in *The Canadian System of Soil Classification*, and in the series descriptions, provide a basis for describing mapping units. These basic sets of soil properties bave been tested and will continue to be tested for genetic relationships and interpretive value.

(c) Soil Series: Concepts, Names, Status and Descriptions. The name of a soil series or a phase of a soil series is the most common reference term used to name soil mapping units in survey intensity level (SIL) 1, 2 and some 3 soil surveys. The purpose of the series category is mainly for practical application and the taxa in the series category are closely allied to interpretive groupings though phase subdivisions are necessary for most purposes. Because the soil series is the lowest category of the classification system, it has the most homogeneous classes.

404.1(c)(1)
(1) Concepts of Series. Guides used to establish new or refine existing series.

(i) Criteria Separating Higher Categories also Separate series. Criteria for distinguishing series include all criteria for setting apart classes in higher categories. A series definition should not encompass criteria groupings found in more that one taxa above the series.[1] The differentiae for orders, great groups, subgroups and families serve as parameters for establishing and revising the concepts and definitions of series.

Criteria for setting apart series within families have more narrow ranges than criteria used to set apart families and classes above families. Many properties used to distinguish series are not used in higher categories.

1 Cyclic pedons may have portions with characteristics falling into two taxa classes. In this situation the pedon is designated to fall into the taxonomic class that dominates (CSSC 1978a, p 19). Thus, the requirement that the limits of a polypedon do not exceed those of the defined series into which it falls does not violate the rule that a series can not straddle the boundary of higher taxa.

404.1(c)(1)(ii)

(ii) Establishing Norms and Class Limits for Series. In developing or revising series concepts, systematic procedures are essential. They assist in preventing the recognition of more series than are necessary to organize and present existing knowledge about soil behaviour. The distinctions between any one series and its competitors must be large enough to be consistently recognized and to be recorded clearly. Each series must be clearly differentiated from all other series. Differentiation can be simplified by using the following systematic procedures;

(A) The available laboratory data, information on morphology, composition, position on the landscape and geographic distribution of the soils under consideration is assembled and studied. This eases the task of reviewing concepts of existing series and arriving at the best possible concepts for new series. The arrayed information is evaluated to determine the desirability of refining norms and class limits for competing series already recognized. This is essential before the data for the new series can be adequately evaluated and the norm and class limits can be determined.

Soil characteristics used to differentiate one series from another are those that are significant for determining behaviour and the kind and sequence of horizons, and that can be observed or be associated with characteristics that are observable, and that can be accurately measured. A significant soil characteristic is one that has genetic implication such as the nature or arrangement of horizons or the absence of horizons, or is one that has an influence on use and management such as percent gravel. Judgment must be exercised in the selection and weighting of soil characteristics used to set apart series. See also the Canadian System of Soil Classification (CSSC 1978a, p 124).

(B) Competing series are those which have common family limits with the series under study. If the concept of either series is changed, the concepts of both are likely to be modified. When the definitions of either of two series that have common family limits are modified, the definitions of both generally are affected and the limits between them must be redefined in revised descriptions.

(C) When a new series is proposed, a model of it is conceptualized. As the model is developed into the proposed series description, a norm and range in characteristics are specified. The range for differentiating characteristics cannot conflict or overlap with that of existing soil series. Limits of the range in soil characteristics for the proposed series maybe as wide as those permitted in the family to which it belongs.

404.1(c)(1)(ii)(C)
Generally, the range of the series is less that the span of the family in at least one differentiating soil characteristic. Ranges cannot be narrower than can be identified accurately and consistently. They must be practical.

(D) A pedon that is typical for the series concept is selected. The typical pedon is a reference specimen to illustrate the central concept for the series. This pedon, along with other very similar pedons, forms the model for the series class. Selection of a typical pedon is thus a very important process and should be done with great care. The selection should be based on the arrayed data on morphology, composition, and geographic distribution. No pedon is likely to be central for all ranges, but the representative pedon should lie reasonably near the center of the ranges of most physical and chemical properties and the geographic distribution. If the pedon selected to typify a series has one or more properties unusual for the series class, these should be recorded as part of the range of characteristics and noted in the section of the description labeled "Remarks."

(E) After the typical pedon has been selected, the permissible ranges in soil characteristics are defined. The arrayed information on morphology and composition of the soils, especially the profile descriptions, field notes, and laboratory analyses, are used.

(F) Only part of the full set of observed properties of any soil is utilized in its classification, although all are considered for use. Thus, not all observable soil properties are necessarily definitive for a series class. The definitive properties that set this series apart from similar competing series are emphasized in the statement of range of characteristics. Also describe the ranges in significant properties that are not differentiating between the series being described and its competing series.

(G) Next the series concept is tested. The norm and ranges in characteristics are checked against the class limits for the family in which the series is placed. The ranges specified for the series must not cross the limits of the family to which the series belongs. The distinctions in definitive characteristics between the norms for the proposed series and the norms for competing series must be clearly larger than normal errors of observation. Ranges in differentiating characteristics must not overlap.

(H) Soil series are seldom set apart on the basis of differences in one characteristic. The distinctions usually are in several characteristics and some are greater than others. If the differences in morphology and composition are clearly greater than the normal errors of observation, and significant to use and management, a series distinction is easily justified.

Problems may arise in deciding whether a new series is needed if two or more properties of the soil to be classified are outside but near the limits of an existing series. New series are proposed if the soils differ in the kind and sequence of horizons or if they have practical significance to use and management. Soils that do not meet these criteria are handled as taxadjuncts (See also Section 301.4(b)(2)(ii)(B)).

(iii) Normal Errors of Observation. A first general guide is that soils for which a new series is being considered must differ appreciably in either or both morphology and composition from soils of already defined series. This means that differences in relevant characteristics must be larger than normal errors of observation or estimate. Some examples of normal errors of observation and of tolerances to be allowed without setting up new series or naming as taxadjuncts are given below as guides.

(A) Identification of soil color in the field is subject to errors because of changes in the quality of light and in soil moisture, differences in the visual acuity and skill of individuals, and limitations in the standards used to determine color. Field observations must be made at different times of day and with differing soil moisture contents. These factors give rise to differences in matching as large as a full interval between chips in the color chart. The scatter in identification of soil color by one person looking at the same specimen at different times and under different conditions or by a group of individuals looking at the same specimen together is an example of "normal errors of observation". Under optimum field conditions, soil color can be matched to within one-half interval between chips in the color chart. The normal scatter of careful observations is plus or minus a half interval between chips in the same sheet or between chips of the same value and chroma on adjacent sheets. Color distinctions, if definitive, between the soils of two series must be larger than this normal scatter.

(B) Field estimates of textures are commonly within plus or minus one-half class of the actual texture, though errors by highly skilled individuals are smaller. To set apart series based in part on differences in texture, the distinctions must be larger than the probable error of field estimates. This holds for the whole soil control section and any of its parts. Not all differences between series are obvious. The limit between fine-loamy and fine-clayey particle-size classes is a clay content of 35 percent. The experienced mapper has little difficulty in distinguishing between a clay content of 30 percent

404.1(c)(1)(iii)(B)

and one of 40 percent. A distinction between 34 percent and 36 percent, however, can be made only in the laboratory. If this is the only difference, the distinction is not important for most uses of the soil map. The delineation could be named for either of the two series that have a common conceptual boundary at 35 percent clay without serious consequences. Many decisions must be made on borderline delineations if the differences are no greater than the normal errors of observation of the experienced mapper.

Even if the estimate of the properties is wrong by these normal errors, the inclusions that result do not seriously affect the use of the map if the mapping units are defined to allow for the possible errors.

(iv) Considerations of Extent. The acreage of each kind of soil that falls outside the limits of any defined series is highly relevant to a decision on need for a new series. A known or estimated extent of about 800 ha or more of a kind of soil outside the limits of any defined series is required before a new series is considered. Beyond that, soils for which a new series is being considered must be clearly outside the limits of any defined series by more than the normal errors of observation before a new series is proposed, even though the extent of the soils equals or exceeds 800 ha. Soils that are marginally outside the limits of defined series are handled as taxadjuncts. Soils with a total extent of less than 800 ha and that are clearly outside the limits of any defined series, and are not appropriate to handle as taxadjuncts or mapping inclusions of similar kinds of soil, are handled as variants. Inclusions, variants, and taxadjuncts are explained in Section

(2) How to Propose a Soil Series

(i) Tentative Recognition. Requests to tentatively recognize proposed soil series are made by presenting appropriate documentation to a provincial soil correlator. After checking the series definition for compliance with the guidelines for establishing new series the provincial soil correlator should forward the documentation with his recommendation, to the regional correlator. The regional correlator should check for conflicting series in neighboring provinces and verify that the proposed name has not been preempted.

(ii) How to Select Names. Geographic place names are preferred as names for series and are used insofar as feasible. Certain kinds of names are avoided. These are:

- Names consisting of less than 6 or more than 22 characters or names of more than two words;

404.1(c)(2)(ii)

- Bizarre, comical and vulgar words;
- Names of animals and plants;
- Geological terms, such as names of rocks, minerals, landforms, and the formations of a locality;
- Given names of persons; unless the name is a known geographic location;
- Copyrighted names and registered trademarks;
- Names essentially identical in pronunciation or similar in spelling to a name already in use.

Sufficient geographic place names which avoid all the restrictions listed above may not exist in a survey area or nearby. Names must then be coined. Coined names must be consistent with common English or French language useage and free from the restrictions listed above. Conventions on abbreviated place names (Sainte) in Quebec and St. or Ste. in other provinces) can be found in the *Soil Names Files*.

(3) Status of Soil Series. The status of soil series is identified as tentative, established or inactive.

(i) Tentative Series. Tentative series status indicates that the series concept is being tested, a series name and abbreviation has been reserved and entered in the Soil Names File and that a draft series description has been submitted to the regional correlator. The proposed concept for the series is still undergoing tests to determine whether it is both valid and of sufficient extent (800 ha) to be recognized. The proposed concept, including range, has been checked by the authors against all known competing series.

(ii) Established Series. Established status means that a tentative series concept has been tested and found to be valid and of at least 800 ha in extent. This status also means that the regional correlator has received and accepted the complete series description, including the typical pedon, lmits and analytical data.

(iii) Inactive Series. Inactive status means that a once established series is no longer being used in any current soil survey. A few soil series are placed on the inactive list because concepts are not well documented, and mapping is not being done in the vicinity where the series was originally used. In this situation, the series must be redefined before it is used again. In other instances, the ranges of two established series may be found to overlap and one of the two is made inactive and no longer used.

Before placing a series on the inactive list, the regional soil correlator sends a memorandum of the intentions and supporting reasons to the other regional and provincial correlators and affected Provincial Units.

404.1(c)(3)(iii)
The regional soil correlator considers the response he receives from the above circulation and notifies the correlators and Provincial Units of his decision. The notification should provide for reclassification to an appropriate series and/or a taxon of a higher category of all pedons of the inactive series that have been sampled and analized. The regional soil correlator should arrange for updating the series status in the *Soil Names File*.

(iv) How to Reactivate Series Names. With few exceptions, the name of a soil series placed on the inactive list will not be used again if it has been used in a published soil survey. Exceptions are permitted when documentation is provided indicating that reactivating the series name will not create confusion with the previously published use of the name.

(v) Dropping Tentative Series. Tentative series commonly are dropped because they:

- Duplicate an already recognized series,
- Seriously conflict with some other series, or
- The total acreage may be too small to warrant recognition of a series, or
- Have not had a firm concept developed during the soil survey.

The request for dropping a tentative series is made by the provincial soil correlator in whose area the type location is located and is sent to the appropriate regional correlator. When a tentative series is dropped provincial soil correlators and Provincial Survey Units should be notified, giving the reasons for dropping the series and providing the appropriate series (or other) classification of the soils for which the series was proposed. The regional soil correlator should also arrange for updating the *Soil Names File*.

(4) Records of Soil Series. The appropriate provincial correlator recommends to the regional correlator changes in series status, classification and other records. These requested changes are reviewed to ensure that they follow the guidelines in the *Canadian System of Soil Classification*, the *Manual for Describing Soils in the Field*, *A Soil Mapping System for Canada* and the appropriate sections of this Handbook. Procedures for maintaining records are as follows.

(i) Changes in Status. Changes in status, classification and series descriptive factors require changes in the *Soil Names File*. The regional correlator should arrange for these updates and for notification of provincial correlators and Provincial Soil Survey Units.

(ii) Changes in Type Location. Changes in series type location, type pedon, and definition of limits require a revised series description including the date of the revision.[1] A copy of all of the current series descriptions will be kept by the regional correlators at LRRI and copies of relevant current series descriptions will be maintained by each provincial correlation team.

The regional correlator responsible for a change in a series description should notify the other regional correlators and the affected provincial correlators as changes occur. Twice a year a consolidated list of changes should be prepared and sent to all correlators, Provincial Unit Heads and other interested people such as University Soil Departments.

(5) Official Soil Series Descriptions. This section outlines the format and content of official soil series descriptions; and the procedures for their preparation, review, approval and distribution.

"Official soil series description" is a term applied to a description that has been carefully tested and found to be necessary and not in conflict with existing series concepts. The description follows a prescribed format. An official soil series description may be revised when more information about the soils in the series is gained. Guides for developing new series concepts and modifying existing concepts are given in Section 404.1(c)(1).

(i) Purposes of Descriptions. The official soil series descriptions are descriptions of the taxa in the series category of The Canadian System of Soil Classification. They serve mainly as specifications for identifying and classifying soils. By defining and naming map units in terms of soil series (or other taxa) the soil surveyer provides a standardized reference through which diverse surveys from different areas and of different scales can be compared.

(ii) Format for Descriptions. This section lists major items and the order in which they appear. Every official soil series description covers all but the "Remarks" and

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1 Editors Note. Hopefully a word processor or other automated centrally located procedure will allow efficient updates of fairly lengthy text materials associated with series descriptions. If appropriate software is prepared the type pedon descriptions could be located in the CanSIS Detail II file.

404.1(c)(5)(ii)
"Additional Data" items which are used only as needed. The sequence of items is listed below:

- Status of Series,
- Initials of Authors, Date and Identification,
- Name of Series,
- Introductory Paragraph,
- Taxonomic Class,
- Typical Pedon,
- Type Location,
- Range in Characteristics,
- Competing Series,
- Geographic Setting,
- Geographically Associated Soils,
- Drainage and Permeability,
- Use and Vegetation,
- Distribution and Extent,
- Series Proposed or Series Established in,
- Remarks,
- Additional Data.

See exhibit (404.1(c)(5)(ii)) for an example of an official soil series description.

(iii) Nature of Descriptions. Each description must be complete, yet as brief as possible without omitting essential information. Each series description must clearly differentiate between the series being described and all other series. The description states the present concept of a series rather than past concepts or how they evolved. It must record the soil properties that:

- define the series,
- distinguish it from other series,
- serve as the basis for the placement of that series in the soil family, and it
- provides a record of the soil properties needed to prepare soil interpretations.

A simple statement giving the classification of a series in categories of the system cannot substitute for a record of soil properties. Listing the placement of competing series in families and subgroups is not a substitute for a statement of the definitive properties that distinguish the soil series from other soil series. Differentiae are stated in terms of soil properties, diagnostic horizons, or features.

404.1(c)(5)(iv)

(iv) Terminology of Descriptions. The standard terminology defined in the *Canadian System of Soil Classification* (CSSC 1978a) and the *Manual for Describing Soils in the Field* (CSSC 1978b) is used as appropriate. Some terms not defined in the two reference publications may be needed in soil description. Such terms are used in their ordinary (standard dictionary) sense.

(v) Preparation. The initial drafts of new or revised series are normally prepared by the Party Chief of the survey where the series is needed. Documentation from the Party Chief (or any other concerned individual) supporting a revised or new series concept is examined by the Provincial correlator for compliance with guidelines for establishing series *(*404.1(c)*)* and circulated to other party chief or provincial correlators that might be affected by the change. The comments from this circulation are considered and the Provincial Correlator forwards the proposal to the regional correlator with his recomendation. In the case of a dispute about the new or revised series the regional correlator acts as arbitrator. Once the revised or new series is acceptable it is listed with the Official Soil Series, and the Official Soil Series Description is stored and circulated as described earlier *(*404.1(c)(4)*)*.

(d) Amendments to *the Canadian System of Soil Classification* in Categories Above the Series. The national soil classification system is dynamic and as new knowledge is gained and soils are examined and described in new places, amendments to the system are required to accommodate the new information. *The Canadian System of Soil Classification* expresses in print knowledge of the system and understanding of soil science up to the time it was published.

(1) Kinds of Amendments. The kinds of amendments that may be expected are as follows:

- Addition of taxa.
- Deletion of taxa.
- Changes in definitions of taxa.
- Additions of diagnostic criteria.
- Clarification of the text not related to any of the above.

(2) Supporting Evidence for Amendments. The amount and kind of evidence required to accompany recommendations for amendments to the soil classification system varies, depending on the nature of the proposed changes. For example, a description of a proposed soil series with interpretations and laboratory data is acceptable evidence to support a new class in the family category.

404.1(d)(3)
Definitions of some taxa may need to be revised to provide more suitable groupings. For these, as a minimum, the supporting evidence must describe the impact of each proposed change on definitions of all taxa that will be affected.

(3) Procedures for Amendments. Soil Scientists wishing to request an amendment to the *Canadian System of Soil Classification* should send their rationale and supporting evidence to the Chairman, Working Group on Soil Classification, Expert Committee on Soil Survey, Land Resource Research Institute, CEF, Ottawa, K1A 0C6.

404.2 Describing Soils In The Field.

The *Manual for Describing Soils in the Field* (CSSC 1978b) provides standard terminology for describing site and pedon characteristics[1]. The proper classification of soil pedons by the *Canadian System of Soil Classification* is dependent upon recognized standard terminology for describing morphological and site characteristics. Similarily, reliable interpretations are based on consistent standards.

(a) Amendments to the *Manual for Describing Soils in the Field*. Amendments to this manual may be periocically required. As new areas are studied and new procedures developed for analizing and interpreting soils provincial or regional groups may wish to propose additions or changes to the current standards. Soil scientists identifying the need for changes should document the need and direct the suggestion to the Secretary, Expert Committee on Soil Survey, Land Resource Research Institute, C.E.F., Ottawa, K1A 0C6.

404.3 Methods of Analyses.
The Manual on Soil Sampling and Methods of Analysis (CSSC 1978c) provides standard procedures for obtaining analytical data. Most soil charactaristics that are measured are not absolute, but rather are method dependent properties. Operationally-defined properties must be determined using standard procedures if consistent results are to be obtained in classifying and interpreting soils.

(a) Amendments to the *Manual on Soil Sampling and Methods of Analyses*. Amendments to this manual may be periodically required. Soil scientists wishing to suggest changes or additions should document the rationale and the need for the change, and direct the suggestion to the Secretary, Expert Committee on Soil Survey, Land Resource Research Institute, C.E.F., Ottawa, K1A 0C6.

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1 *The Manual for Describing Soils in the Field* also provides the computer coding procedure for data entry into the Canadian Soil Information System (CanSIS).

404.4 Describing and Naming landforms.

The landform classification described in *The Canadian System of Soil Classification* (CSSC 1978a, pp 141-157) provides standards for identifying and naming landforms that are associated with pedon sites and map units. The landform classification describes the shape and pattern of the land surface and frequently provides inferences as to the nature of the materials upon which the soils are forming or formed. This facilitates the description of the spacial relationships between the various pedons associated with given landscapes.

(a) Amendments to the Landform Classification. Amendments to the Landform Classification may be required as more experience is gained in new areas or with various map scales. Scientists identifying the need for changes in the landform classification should present their rationale and supporting evidence to the Chairman, Working Group on Soil Classification, Expert Committee on Soil Survey, Land Resource Research Institue, C.E.F., Ottawa, K1A 0C6.

404.5 Mapping Systems.

Soil maps generalize and group information about soils and landscapes, displaying information about a large tract of land on a piece of paper that can be placed on a desk top. Standardized conventions for arranging and explaining the groupings and for expressing the reliability of the map are necessary in order to obtain the maximum benefit from the soils maps.

(a) A Soil Mapping System for Canada. This publication (ECSS 1981) sets out some of the mapping principles that aid in standardization of mapping procedures. As more experience is gained using these guidelines it undoubtedly will be necessary to expand and revise them. Soil Scientists identifying the need for revisions in *A Soil Mapping System for Canada* should present their rationale and supporting evidence to the Secretary, Expert Committee on Soil Survey, Land Resource Research Institute, C.E.F., Ottawa, K1A 0C6.

OUTLINE

Soil Survey Handbook

100 Soil surveys in Canada - John Day

101 Cooperating agencies and shared programs

200 Planning for soil surveys - John Day

201 Plans for the Nation
- .1 Role of the *Expert Committee on Soil Survey* (ECSS)
  - (a) Minutes and technical proceedings of ECSS.
  - (b) Recomendations of ECSS
- .2 *Canada Committee on Land Resource Services* (CCLRS)
  - (a) Contribution to soil survey operations and planning
- .3 *Canadian Agricultural Research Council* (CARC)
  - (a) Contribution to soil survey operations and planning
- .4 *Canadian Agricultural Services Coordinating Committee*
  - (a) Contribution to soil survey operations and planning

202 Plans for the provinces or territories
- .1 *Provincial Soils Advisory Committees*
  - (a) Minutes of work planning meetings.
- .2 *Provincial Institutes of Pedology*
  - (a) Minutes of work planning meetings
- .3 Preparing the provincial soil survey plan of operations
  - (a) Recomendations from and to the *National Committees*
  - (b) Current status of soil surveys, Index and maps.
  - (c) Evaluation and use of older published soil surveys
  - (d) Use of soil surveys

203 Planning and evaluating a proposed survey
- .1 Preparation of terms of reference and general specifications
- .2 Identification of special soil investigations.

300 Managing soil survey operations - Wayne Pettapiece

301 Plans of operations
- .1 Yearly plan of operations
- .2 Budgeting
  - (a) Current fiscal year
  - (b) Submissions for next year
  - (c) Financial reporting
- .3 Contract specifications and quality control procedures

302 Annual progress reports
- .1 Accomplishments - goals met.
- .2 Plans for next year.

400 Conducting soil surveys - Gerald Coen

401 Detailed plan for the survey project area
- .1 Project specifications
  - (a) Description of the area to be surveyed
  - (b) Purposes of the survey
  - (c) Cooperating agencies
  - (d) Mapping specifications
  - (e) Interpretations
  - (f) Staff
  - (g) Equipment
  - (h) Kind of mapping base for field work and publication
  - (i) Laboratory analyses and special studies
  - (j) Publication plans
  - (k) Schedule
  - (l) Other items

402 Assembly of resource information
- .1 Cultural and land use information
- .2 Aerial photographs, mosaics, other imagery
- .3 Natural resource information
- .4 Requirements to fill perceived gaps
  - (a) Aerial photographs
  - (b) Base maps
  - (c) Contract information

403 Allocation of duties
- .1 Party leader
- .2 Mappers
- .3 Student assistants and casual employees
- .4 Laboratory analysts
- .5 Draftsmen
- .6 Correlators
- .7 Special investigations cooperators

404 Standards for soil classification, mapping and quality control
- .1 Soil taxonomy
  - (a) Form and content
  - (b) Use and application to soil survey
    - (1) General
    - (2) Relationships between soil taxa and mapping
  - (c) Soil series: Concepts, names, status and descriptions

(1) Concepts of series
(i) Criteria separating higher categories also separate series
(ii) Establishing norms and class limits for series
(iii) Normal errors of observation
(iv) Considerations of extent
(2) How to propose a soil series
(i) Tentative recognition
(ii) how to select names
(3) Status of soil series
(i) Tentative series
(ii) Established series
(iii) Inactive series
(iv) How to reactivate series names
(v) Dropping tentative series
(4) Records of soil series
(i) Changes in status
(ii) Changes in type location
(5) Official soil series descriptions
(i) Purposes of descriptions
(ii) Format for descriptions
(iii) Nature of descriptions
(iv) Terminology of descriptions
(v) Preparation

(d) Ammendments to the *Canadian System of Soil Classification* in categories above the series.
(1) Kinds of amendments
(2) Supporting evidence for amendments
(3) Procedures for amendments

.2 Describing soils in the field
(a) Amendments to the *Manual for Describing Soils in the Field*

.3 Methods of analyses
(a) Amendments to the *Manual of Soil Sampling and Methods of Analyses*

.4 Describing and naming landforms
(a) Amendments to the landform classification

.5 Mapping systems
(a) *A Soil Mapping System for Canada*

.6 Correlation
(a) Project specifications (Soil Survey Form 1)
(b) Progress reviews (Soil Survey Form 2)
(c) Soil Names File
(d) Data quality (procedures for verification of detailed soil descriptions, analytical data).

.7 Cartographic standards

405 Preparation for surveying

- .1 Review work plan
- .2 Review reference material
- .3 Assemble equipment, materials
- .4 Party leader fast field once-over trip
- .5 Preliminary photo interpretation
- .6 Prepare key to photographic recognition of major mapping units
- .7 Compile preliminary map legend and description of map units
- .8 Test map sample areas and conduct transects to test and revise preliminary legend major map units descriptions
- .9 Revise and finalize mapping legend
- .10 Compile estimates of daily mapping rate attainable
- .11 Prepare revised work plan
  - (a) Staff
  - (b) Budget
  - (c) Schedule
  - (d) Supporting activities
- .12 Prepare documentations for first field review

406 Soil Mapping and supporting activities

- .1 Allocation of duties
  - (a) Party leader
  - (b) Mappers
  - (c) Students
  - (d) Laboratory analysts
  - (e) Special investigations cooperators
  - (f) Supervisor of party leader
  - (g) Provincial correlator
  - (h) National correlator
- .2 Mapping the soil resource
  - (a) Party leader introduces staff to area, explains mapping legend and identification key
  - (b) Data recording methods
  - (c) Map compilation
  - (d) Estimating soil properties
  - (e) Conducting special investigations in the field
  - (f) Soil sampling
  - (g) Preparation of soil report manuscript
  - (h) Finalizing the map legend
  - (i) Completing field review change documents
  - (j) Final field review
- .3 Laboratory investigations and processing of anlaytical data
- .4 Role of CanSIS soil data and cartographic data fields feedback during latter stages of mapping.

500 Application of soil survey information

501 Predicting soil behavior
502 Estimating soil properties (406.2(d))
503 Rating soil for selected uses
.1 Sanitary facilities
.2 Building site development
.3 Construction material
.4 Water management
.5 Recreation
.6 agriculture
.7 Forestry
504 Soil Potential ratings
505 Collecting data on soil behavior
506 Coordinating and testing soil survey interpretations
507 Computerizing soil survey interpretations

600 Soil survey investigations - Alex McKeague

601 Scope, organization and cooperative arrangements
602 Responsibilities and general planning
603 Benchmark soils, standard and reference samples
604 Managing and conducting soil survey
.1 Introduction
.2 Studies of soil properties at field locations (see 406.2 duplication?).
.3 Planning soil sampling and collecting
.4 Shipping, transporting and storing soil samples
.5 Technical assistance
(a) Universities
(b) Agencies other than soil survey
(c) Soil survey unit laboratories
(d) Analytical services laboratory LRRI
(c) Research scientists LRRI
.6 Procedures manuals
(a) Methods of analyses
(b) Soil water investigations methods manual
.7 Remote sensing methods

700 Information and Display Systems
701 Media used to inform the public
.1 Information for non-technical users
(a) Published soil surveys; How to obtain and use
(1) Soil Survey monographs and maps
(2) Interim soil survey reports and maps
(3) Soil survey maps with expanded legends
(4) Exploratory soil survey reports and maps

(b) Popular publications
(c) Newspapers and magazines
(d) Television and radio
(e) Displays in public places

.2 Information for technical users; guidelines for preparation
(a) Soil Survey investigation report (research)
(1) Presentation at learned societies
(2) Contribution to referred journals
(b) Interim and annual reports
(c) Soil handbooks
(1) System of soil classification for Canada *(see 404.1)*
(2) CanSIS manuals *(see 404.2)*
(3) Official soil series descriptions for the province *(see 404.1(c))*
(d) Summaries of data stored in CanSIS
(1) Soil data file
(2) Soil names file
(3) Soil cartographic file
(4) Soil management file
(e) Other maps (not associated with soil survey reports)
(1) Small scale maps
(i) Soil landscape maps
(ii) Physiographic maps
(iii) Climatic or agromet maps
(iv) Capability maps of provinces
(v) Index to Soil Surveys
(2) Medium scale maps
(i) CLI capability for NTS sheets
(ii) Northern land use informatin series maps of NTS sheets
(iii) Land use systems maps

702 Automating soil survey and other information - Julian Dumanski (After April 1983)

.1 Canadian Soil Information System (CanSIS)
(a) Soil data file
(b) Soil names file
(c) Soil cartographic file
(d) Soil management file

.2 Canadian geoinformation system (DOE)

.3 Other Canadian soil information systems
(a) Provincial
(b) University
(c) Others

.4 Climatic data

.5 User policies for CanSIS

703 Guides for preparing and reviewing soil survey reports and maps - Cliff Acton
.1 Purpose and scope
(a) Monographs and maps
(b) Interim soil reports and maps
(c) Soil maps with expanded legends
.2 Content
(a) Preparation of report outline
(b) Soil descriptions
(c) Soil properties
(d) Soil maps and legends
(e) Other thematic maps and legends
(f) Soil interpretations and ratings
(1) Interpretation rating guides
(2) Tabular ratings
(3) Extended legend ratings
(g) Derived factor and interpretation rating maps and legends
(h) Design and packaging
(1) Probable Production agency
(2) Number of copies
(3) Distribution list
(4) Distribution agency
.3 Automating Soil Survey report compilation
.4 Quality control processes
(a) In-house review
(b) Provincial correlator review
(c) National correlator review
(d) Editorial review
.5 Scheduling of stages of compilation and production
(a) Soil report
(1) Assignment of authorship
(2) Review of progress at correlation levels 1,2,3 and 4
(3) Submission of completed manuscript to provincial and national correlators and editor
(4) Submission of corrected manuscript to printer
(b) Maps
(1) Base map materials ordered
(2) Base map materials completed and delivered to survey unit
(3) Transfer of soil information to base map
(4) Compilation of interim maps and legends
(5) Compilation of combined maps and legend
(6) Final check by party leader and provincial correlator
(7) Receipt, evaluation and cartographic production estimates by chief cartographer and national correlator

(8) Surveyors's color proof check
(9) Submit corrected negatives to printers
(10)Deliver folded maps to distributor or report printer.

SSH - June 1, 1982

Report on Quality Control and Methods of Analyses in Soil Laboratories

P. Haluschak

In response to concerns on soil data quality expressed at the 1981 ECSS meeting, information was circulated to various soil laboratories for discussion on ways of improving soil data quality and methods of analyses. A summary of this information was compiled and used as a basis for proposals presented at the 1982 ECSS meeting.

The terms of reference for this working group were discussed at the 1982 ECSS meeting and restricted to "improving the quality and uniformity of laboratory data."

As mentioned previously, the objectives for this group have been modified to incorporate concerns brought forward during the 1982 meeting. They are summarized as follows:

(1) To update and compile a list of laboratories that should be involved in standard sample analyses. A brief outline of methods used in laboratories would also be compiled.
(2) To collect and distribute additional standard samples and to use a standard sample as a check with every batch analyses. Unknown samples be distributed for analyses periodically.
(3) To compile error values for methods of analyses.
(4) To review and standardize methods which are presently used, but are not included in the methods manual.
(5) To establish a record of performance for soil analyses, whereby the number of samples per analyses per day could be determined and a cost per sample for various analyses assigned.
(6) To develop a computerized recording and analyses file, through CanSIS, for use in routine laboratory operations.
(7) To high-lite ongoing activities and new developments in soil laboratories by means of a newsletter.

Finally, the following remarks were expressed by members in attendance.

(1) That an indication of the most appropriate method or methods for specific soil conditions would be useful/
(2) What is the status of S.I. units in laboratory data display in reports, CanSIS, etc.?
(3) How compatible are methods of soil analyses on a regional bases.

CanSIS Working Group Report

B. Kloosterman

Introduction

The CanSIS Working Group was reestablished in 1981 as a result of the need for more active involvement in CanSIS by the regions. The prime objective of the group is to provide a communication channel by which the direction of the system might remain in tune with the needs of those who are serviced by it.

Discussion

The group met Monday morning April 21, 1982 from 8:30 to 12:30. The 18 persons in attendance represented every region although several conflicts with other sessions reduced representation from some areas.

The session focused on where CanSIS is going in terms of development, policy and regional growth. The prime focus of the meeting was on a draft statement dealing with CanSIS policy and data security.

Highlights of this presentation were:

a) Flexibility of the national system for data input at the same time maintaining standardization of data variables and storage formats.

b) Maintain high standards of quality control by manual and computer assisted techniques.

c) Standard computer output for all contributors to the system.

d) Software support.

e) All data available to pedologists and agronomists for research purposes and development of recommendations produced free of charge.

f) Cooperators of map data will receive a reasonable number of computer drawn derived and interpretive maps.

g) Service priorities by agencies with the Canada Committee on Land Resource Services at the top and non-government or university at the bottom.

h) Promotion of data compatibility between local and national files.

i) Future emphasis on enhanced local data management capability and development of computerized procedures for data integration with other information systems.

A good deal of concern was expressed for access to data in the system by private consultant groups. A parallel issue was data security on the system, which at present is very limiting. The discussion stressed the need for only clean data going into the national file (On RAPID)

There was general agreement that treatment of unusual requests be considered on an individual basis and that some sort of service charge by levied for data access.

A second issue of the meeting dealt with a questionnaire on training needs in the regions. It dealt with two aspects:

a) From which files are data outputs desired.

b) What training is required to effect these outputs locally.

It was noted that CanSIS staff can provide training in the following areas:

- general overview
- data collection
- map retrievals
- RAPID (data base)
- EASYTRIEVE (report generator)
- SAS (statistical analysis)
- computer legends
- use of spatial display point plot package

The files which are available for data retrieval are:

- soil names
- soil data (DETAIL 2)
- dailies
- performance management
- land potential
- computer legends
- cartographic maps

A second questionnaire to assess the needs of prime users as to their EDP requirements now and in the future and the roles of CanSIS is satisfying these needs. The document attempts to assess the present activity in data processing and to anticipate requirements over the next few years. On the basis of the discussions, the questionnaire has essentially been finalized. Regional units will be visited by CanSIS Staff over the next few months to collect data for the study using this form.

A proposal was tabled to effect a cosmetic update of the Manual for Describing Soils in the Field in preparatory to reprinting. Regional input will be solicited to priorize changes that will impact the system. These activities will gain momentum in the 1983-84 fiscal year.

Presentations on consistency checks were presented at two levels:

a) Order level checks on the basis of soil classification.

b) Soil property checks in terms of other variables.

After evaluation of the proposals, the most important checks will be patched into the system.

Recommendations

The following recommendations are made:

a) That the CanSIS policy statement be modified in lieu of the assessment study and then circulated to assess its applicability.

b) That soil survey units cooperate in contributing to the data and assessment questionnaires. This will help to determine the best application of scarce CanSIS resources for optimal regional benefit.

c) That non-systematic changes be made to the manual for describing data in the field and reprinted. Work will then commence on a full revision.

d) That the consistency check development by CanSIS working group members be assessed for accuracy and that order level checks be programmed into the system.

COMPUTERIZED SYSTEMS FOR DATA MANAGEMENT AND ANALYSIS OF SOILS INFORMATION WITHIN BRITISH COLUMBIA

Mark Sondheim, Ph.D.

Soils information may be considered in two contexts: point data, referring to a specific pedon description, and polygon data, referring to a given bounded area on a map. In British Columbia there are at present three computer systems designed to handle these two types of information.

1. Point Data: British Columbia Soil Information System (BCSIS)

   BCSIS is a point source information management system incorporating site, soils, and laboratory data. The main objectives of the system are: to increase accessibility and reliability of soils information; to increase accuracy, volume, speed of response, and sophistication of interpretations; to increase speed of legend development; to increase ability to integrate soils data with other resource data. The system includes a number of easy to use functions related to data control, data management, and report generation. For data analysis, BCSIS is designed to be used in conjunction with the commercially available Statistical Analysis System. The surveyor can expect to access and manipulate his data within one to two weeks from the time he submits his field forms. BCSIS resides on the Victoria mainframe computer but is accessible as well in other cities through the DATAPAC and SNA communications networks.

2. Point Data: Soil Laboratory System (SLS)

   SLS is an interactive, PDP 11/24 based minicomputer system designed to capture physical and chemical soils data determined in the soils laboratory in Kelowna. The main objectives of the system are: to increase the volume of samples which the lab can process, by eliminating the need to maintain lab notebooks and paper administrative records; to allow quick and accurate entry of the data into BCSIS files, by providing for the transference of final results to the mainframe in Victoria over the DATAPAC network. Raw data is entered into a number of video terminals located in the lab. The system is fully compatible with future placement of electronic links between the lab equipment and the computer.

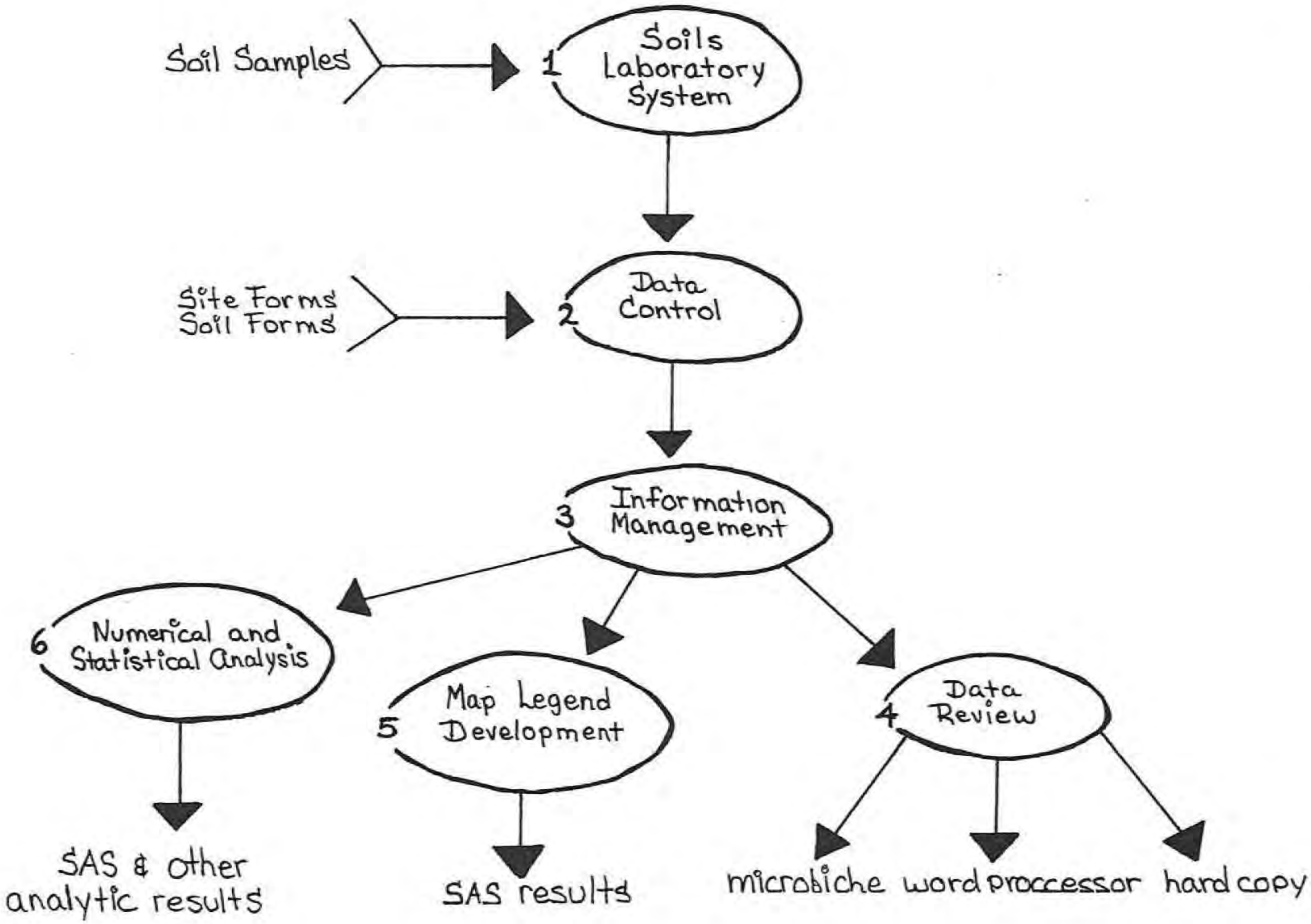
3. Polygon Data: Computer Aided Planning, Assessment, and Map Production (CAPAMP)

The two major components of CAPAMP include base mapping, specifically planimetric and cadastral maps, and thematic mapping, specifically soils, terrain, forest cover, agricultural capability, and wildlife capability maps. The main objectives of the project are: to increase the rate of map production by automating the drafting process; to increase the numbers, types, and availability of derivative and interpretive maps. Each polygon has associated with it, a label and additional attributes. For soils, information may also be entered and retrieved on a mapping unit basis. The derivative and interpretive maps may be produced by manipulation of the attributes associated with one or more of the five thematic maps above. An interface between BCSIS and CAPAMP is anticipated at some time in the future. CAPAMP employs Intergraph (M&S) equipment in Victoria, utilizing an interactive graphic design system and a data management and retrieval system.

B. C. SOIL INFORMATION SYSTEM

(BCSIS)

POINT DATA



B.C. SOIL INFORMATION SYSTEM

1. Results of chemical and physical soil analyses are entered into a computerized soils laboratory system. The data is transferred to Victoria over DATAPAC communications lines.

2. All (non-digital) data are key entered onto tape and then entered into the system. Subsequently, all data fields are verified to contain allowable entries. Any errors are corrected.

3. Validation occurs: cross-checks between fields are made; horizon designations are verified; soil taxonomic classification is validated. Errors are rectified, the data is edited and validated again, and finally the profile may be officially promoted as valid data. Data extract procedures, applied to points 4, 5 and 6 below, are also contained here.

4. Reports on the new data or on analytic results may be produced on paper or microfiche. Reports may also be transferred directly to AES word processors for further manipulation.

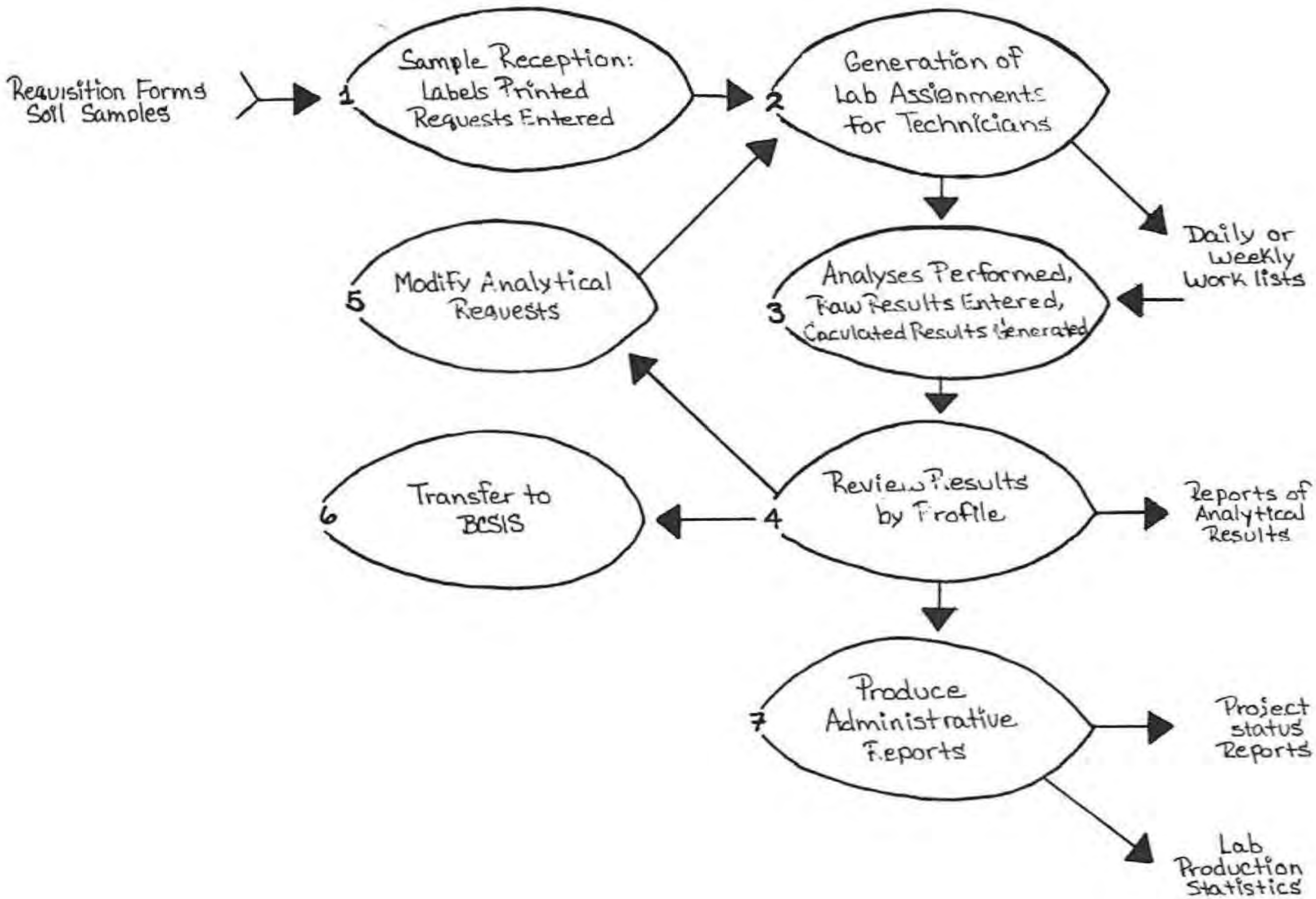
5. Parametric and non-parametric routines may be used to facilitate the map legend development process. These routines will be run with the commercially available Statistical Analysis System (SAS).

6. Analyses for any other purposes may also be generated with SAS. SPSS and selected other programs are available. Routines will be developed for specific soil interpretations.

SOIL LABORATORY SYSTEM

(SLS)

POINT DATA



SOIL LABORATORY SYSTEM

1 The surveyors send forms with their samples. The forms indicate requests for groups of standard analyses or individual analyses. A technician enters the name of the surveyor and the requests. The computer prints a sticky label for each sample.

2 The computer produces individual lab assignments for the technicians according to project priorities established by the head of the laboratory. A paper work list is printed for each technician, showing laboratory sample numbers. The work list becomes the laboratory notebook during the implementation period and in the event of system failure.

3 A technician enters raw data, such as soil + tare weight and tare weight, into a video terminal. The corrected result is displayed. Different video screens correspond to different analyses. After the technician accepts the data, calculated results are internally produced whenever sufficient data exist; these include carbon-nitrogen ratio, AWSC, unified soil classification, etc.

4 The head of the lab reviews the results, typically by project and profile. Assuming he is satisfied with them, he can instruct the computer to print reports to be sent to the surveyor. The report consists of the surveyor's name and address and the results listed by profile.

5 If he is not satisfied, he may ask that tests be repeated and/or that additional tests be made.

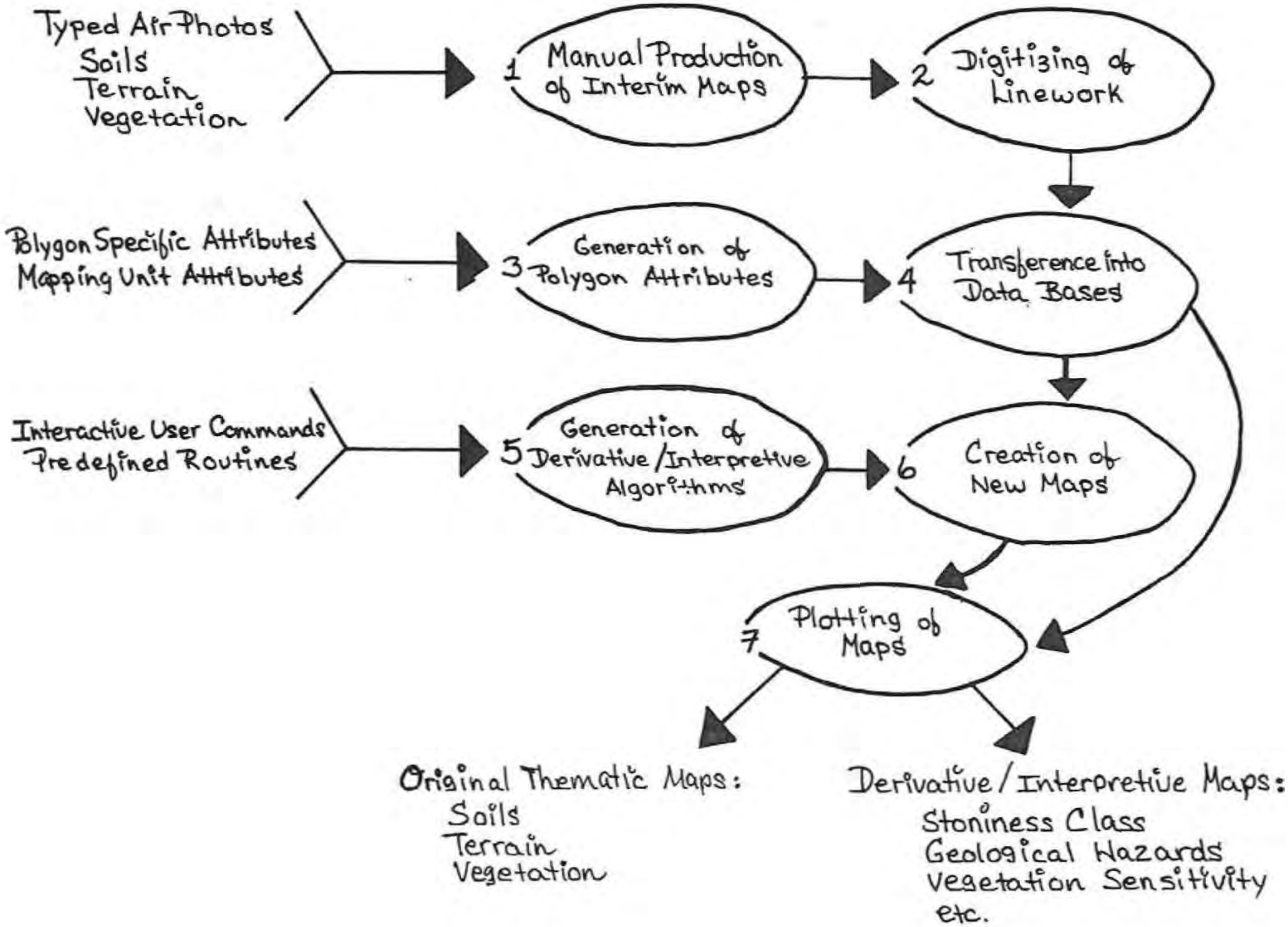
6 All data which are officially accepted by the head of the lab are ready to be transferred to the B.C. Soil Information System. This transfer is made generally once or twice a week.

7 Bookkeeping reports may be produced any time they are required.

COMPUTER AIDED PLANNING, ASSESSMENT, AND MAP PRODUCTION

(CAPAMP)

POLYGON DATA



COMPUTER AIDED PLANNING ASSESSMENT AND MAP PRODUCTION

1 Manuscript maps are produced by a draftsperson from typed air photographs provided by the soil, terrain and/or vegetation surveyor.

2 Using a cursor, the polygon boundaries are digitized.

3 Data characterization of each of the polygons occurs. For data entry, information may be included on either a polygon specific or a mapping unit basis.

4 The resulting linework and polygon attributes are stored in the interactive graphics design system (IGDS) and the data management and retrieval system (DMRS), respectively.

5 Algorithms for the production of derivative or interpretive maps are generated when required. This is done interactively either by writing simple user commands or by employing predefined routines. In either case the algorithms are based on manipulation of the attributes in the DMRS.

6 New maps may be produced by amalgamation of existing polygons on a single map or by overlaying two or more existing maps. The nature of a new map is determined by the algorithms used to define it.

7 Both the original thematic maps and any of the derivative or interpretive maps may be plotted on a topographic base map. Editing and validating of the linework and the polygon attributes occurs not only here but also in previous steps. Maps may also be viewed on computer terminal screens.

Report to ECSS on Progress of Map Unit File Considerations

W.W. Pettapiece

The chairman was approached in December to canvass the pedological community on the need or advisability of expanding the CanSIS file system to include a Map Unit File. Each area of the country was contacted through a selected representative as follows: British Columbia - Evert Kenk and Dave Moon, Saskatchewan - Bill Souster, Manitoba - Wally Fraser, Ontario - Cliff Acton, Quebec - J.M. Cossette, Atlantic - Alan Stewart.

To help direct the response, the following questions were asked:

1. Should we be developing a map unit description (MUD) form?
2. Should it have a more or less standardized content?
3. Is there a need for a national registry?
4. Assuming a file is to be developed, what should it contain?
5. If a computer file is to be developed what constraints will this have? What format? Should it be exhaustive or contain only a minimum of information.
6. If one put into the computer the legends of the available maps or map symbols from digitized maps, would he not have a map unit file? Could one then generate by computer any requirements such as interpretations?

To give the correspondents something specific to react to a sample of the Alberta form was enclosed along with a brief explanation of its use (appended). Reaction to this form included :

a) it contains most of the land information required
b) it has no interpretation
c) it is not computer compatible

There was nearly unanimous agreement on most points with some minor variations. The response can be summarized as follows:

1. Map unit description forms could be useful in those areas where a strongly controlled legend is being employed.
2. We can all use some guidance on standardization.
3. There is no need for a national file. It is primarily useful as correlation tool at the local level.
4. If a file was to be developed it should contain the information on the Alberta sample plus data on land-use, interpretations and transect data if available.
5. The first consideration is to decide if in fact there is enough justification to develop, use and maintain a computer file. If

there are only a few hundred forms then it is probably not required. If a MUD form were to be "computerized" then it would need to be quite structured. Free format information is hard to access and manage. Things like X-sectional diagrams are particularly difficult.

6. Legend information would give a MUD only in the case of a closed legend. However unique symbol lists could serve the same purpose for a minimum of information.

The one aspect which came out very strongly in all cases was that an expanded Soil Names File would be of greater use. Indeed, several provinces indicated that they were developing these on a local bases. Expanded meant additional information such as ecological or physiographic constraints, interpretations, better series definitions, etc. I agree with this approach whether at a local or national level, but it brings out several points which I feel should be addressed before we proceed.

1. what does a "name" mean? Do we mean something approaching a series? In that case what climatic (ecological) constraints or limits should be used? Should they be national or regional (I prefer the latter).

2. to be useful we must have better correlation. It is not acceptable that a single "series" can have several interpretations (keeping slope phases constant). I find that indefensible when explaining soils, soil surveys and their uses. Also, if we wish to use the computer for more than archiving (and we surely do) then interpretations should follow consistent and logical rules. One may specify different interpretations but should not modify an existing system to allow for a local management consideration. CLI class 5t (because of a topographic limitation) should remain 5t even if a farmer cultivates it, because either it cannot be sustained or he must use special management inputs. If he can afford to do the latter (because of high value crops eg.) fine but it stays as class 5t under the original guidelines. If we don't insist on these kinds of controls we drastically reduce the effectiveness of a mechanical system and increase our own documentation problem. This is analagous to the argument that one can engineer for any circumstance - its only a matter of money. A "poor" rating for an engineering interpretation doesn't mean it can't be done - but it would require higher inputs. Interpretation should not be substituted for planning - they are two separate functions. Planning should be related to interpretations but they should not be equated.

3. A third point concerns the issue of compatibility. Is there a need to expand the national soil names file to include some of these other

parameters if only half the country is going to use the national system? Or, is it sufficient that each province or region does the expansion as long as they use a standard set of guidelines? I got the feeling that at the present time a majority of regional people preferred the latter (or were already doing it) but would be prepared to work on compatibility at some later date. Someone with a systems outlook should consider the implications of the approach.

The above comments notwithstanding, the items which should be considered in a expanded soil names file are:

1. climatic (ecological) limits - in Alberta we place emphasis on Agroclimatic regions.

2. major physiographic regions?

3. better description or definition of the "name" limits in terms of chem., phys., & pedological parameters.

4. interpretations (generated?).

Summation

1. A Map Unit File could be a useful tool but is mainly applicable at a local level. A national file is not recommended.

2. Highest priority in this area is for an expanded Soil Names File.

3. There are implications for more stringent controls on our correlation procedures.

Heading

NAME: 131

Map Unit

Described by:
Checked by: Date:

Setting

Ecological Region:
(soil zone - vegetation region)

Physiographic Area:
(including region)

Associated landform(s):
(including slope)

Drainage:

Associated vegetation:

Map Unit

Parent material(s):

Profile type(s): (include series names where established and approximate percentages

Dominant -

Significant -

Inclusions -

Diagram:

Comments:

Correlation

Project and scale of mapping:
Competing units:

Representative site:

Representative stero pair:

Pictures:

REPORT TO THE ECSS OF THE SOIL DEGRADATION WORKING GROUP (SDWG)

D.R. Coote

The first meeting of the Soil Degradation Working Group was held on Monday, April 19, 1982, from 13:30 to 15:30, in the Parliament Buildings, Victoria, B.C. The meeting was also attended by approximately 40 observers. The Chairman introduced the topic with a brief description of the major soil degradation concerns, i.e. soil erosion, salinization, acidification, compaction and loss of organic matter. Soil disturbance and contamination, landslides and subsidence of organic soils were also mentioned.

Each member of the initial working group had the opportunity of expressing their concerns and their perceptions of the role of the group. The opinions expressed included:

- the need to concentrate on research to develop methodologies for identifying and mapping degradation problems at the soil survey level;
- the need to develop legends for use with degradation maps in different provinces;
- the need to replace the term "degradation" with a word not associated with leaching of soils;
- the need to promote education about soil degradation, especially soil erosion;
- the need to establish "benchmark" sites for long-term degradation monitoring;
- the need to examine the effects of crop rotation and management changes on soil quality;
- the need for the Working Group to take on a coordinating role between provincial work and national mapping;
- the W.G. should concentrate on only one topic at a time.

Because of the large number of people present at the meeting, it was decided to open the discussion to all who wished to contribute their opinions and observations. There emerged from the discussion two distinctly different objectives which had to be addressed. One of these was to develop, select, research and otherwise adapt for soil survey purposes, methodologies which could be applied during the preparation of a soil survey report to rank and compare, through field observations and data analysis, the present and potential deterioration of different soils. The second major requirement was to prepare maps of the location, extent and severity of soil deterioration processes currently active in Canada, so as to provide a clear indication of the importance of soil degradation assessment to both the federal and provincial governments, as well as to the soil survey user.

Some of the other main points in the discussion included needs for:

- the identification of simple indicators of soil degradation;
- the research and development of remedial practices;
- the identification of manpower and equipment needs for the soil survey to do the job properly;
- provision of information to other government departments;
- the use of economic analysis to determine the cost of not controlling soil deterioration.
- measurements and assessments of past soil degradation;
- the inclusion of interpretations of degradation risks in forested areas.

A second meeting of the Working Group was held on Wednesday, April 21, 1982 at the Harbour Towers Hotel. From this meeting emerged a concensus as to the need to follow a simultaneous approach to include both generalized soil degradation maps and detailed soil survey procedures as follows:

(i) To prepare "overview" maps indicating the "risk" of different kinds of soil deterioration. The scale should be 1:1 Million, or larger where practical. The maps should be supplemented by information from soil survey and extension specialists at the regional and local levels to provide an assessment of the degree to which the risks indicated on the maps were actually being translated into soil problems because of management practices. Statistics Canada will be approached to provide comparable scale mapping of 1981 Census of Agriculture data to overlay on the risk maps. An example of a 1:1 Million risk map for wind erosion was presented by the Chairman. It was based on the Soil Landscape maps of Manitoba and Saskatchewan (J. Shields), using surface soil moisture (based on the Versatile Soil Moisture Budget) and wind speeds for the April-May period, and soil texture in a prediction equation derived from published work by W.S. Chepil. With a crop and soil management overlay, the map could be used to estimate the probability of the risk shown on the map being realized as a problem in the field. It was agreed that similar approaches, using the same map base, could be initiated for water erosion, salinization and acidification. Members of the Working Group volunteered to work on the overview risk mapping as follows: water erosion - G.J. Wall; wind erosion - D.R. Coote; salinity - R. Eilers; acidity - H. Rostad (west) and H. Rees (east). It was agreed that such an approach was not possible at the present time for other soil degradation processes, but that further investigation of the possibilities would be pursued.

(ii) To prepare a review of literature on, and experience of, the probable data and equipment needs for the soil survey to include assessments and interpretations of current and potential soil degradation in new soil survey reports. This should include classification criteria and methodologies, manpower and research needs, user requirements and data storage needs.

Volunteers to undertake the preparation of these reviews were as follows: Water erosion - G.J. Wall; wind erosion - G. Padbury; compaction - L. van Vliet; organic matter loss - G. Patterson; salinity - R. Eilers; acidity - H. Rostad (west) and H. Rees (east); and contamination by heavy metals and toxic materials - J. MacMillan.

This approach should enable the Working Group, for next year's meeting, to prepare a listing of the equipment and manpower needs which will have to be forthcoming in order to incorporate soil degradation measurements into soil survey procedures. It will also provide a preliminary list of research needs.

The initial terms of reference of the Working Group have been modified to reflect the approaches outlined above, and are presented here:

Preliminary Terms of Reference, Soil Degradation Working Group, Expert Committee on Soil Survey

To guide and assist in the implementation of a cooperative program within the Land Resource Research Institute, Provincial Institutes of Pedology, University Soils Departments and other involved and interested agencies, with the following objectives:

1. National level.

Identification of the location, extent and degree of severity of soil degradation across Canada at a scale suitable for:

(a) Providing status information on different soil degradation problems for policy makers and planners, and for use in explaining the importance of soil degradation research relative to other competing concerns.

(b) Providing educational base line material for use by researchers, extention specialists, universities and colleges, and soil survey user groups.

(c) Providing background material for international cooperative programs such as United Nations Environmental Program, the UN World Soils Policy, FAO Land Degradation Maps; and Canada - U.S. programs such as acid rain impact assessment.

(d) Providing a data base for modelling the impact of land use and management changes on potential soil deterioration - a "what if" assessment.

2. Regional level

Evaluation of individual soil map polygons at the published Soil Survey scale for the purpose of:

(a) Estimating the rate at which degradation appears to be progressing (or retreating)

(b) Predicting the potential for future degradation, employing a number of soil and crop management scenarios (alternatives)

(c) Identifying past degradation (if any).

(d) Presenting the results of the above in a useable form - interpretive maps, tables, written text etc.

3. Both regional and national levels (future activities)

(a) Establishment of a series of bench-mark sites, strategically located across the country, the monitoring of which should provide a quantitative and continuing record of the positive and negative changes occuring in major representative soils of Canada.

(b) Preparation of information materials on the alternatives available to control different kinds of soil degradation, and to reclaim degraded land.

Methodology for the Interpretation of Soil Inventory

Dr. Greg Wall presented a methodology for the interpretation of soil inventory data for soil erosion potential. These methods were presented in part at the ECSS meeting of 1980 and 1981. A manual for interpretation of soil survey data for soil erosion by water is currently being prepared for publication in the fall of 1982.

Expert Committee on Soil Survey, Working Group on Soil Degradation

Memberships, April 1982

Roger Baril, Université Laval, Faculté des sciences de l'agriculture et de l'alimentation, Québec, P.Q., G1K 7P4.

D. Richard Coote (Chairman), LRRI, Agriculture Canada, Ottawa, K1A 0C6.

Robert Eilers, Manitoba Soil Survey, Soil Science Dept., University of Manitoba , Winnipeg, Man. R3T 2N2.

John K. MacMillan, Plant Industry Branch, Dept. of Agriculture and Rural Development, P.O. Box 6000, Fredericton, N.B. E3B 5H1.

John L. Nowland, Research Branch, Agriculture Canada, 7th Floor, Sir John Carling Bldg., Ottawa, K1A 0C6.

Glen Padbury, Saskatchewan Institute of Pedology, University of Saskatchewan, Saskatoon, Saskatchewan, S7N 0W0.

Gary Patterson, Alberta-Canada Soil Survey, 6th Floor, Terrace Plaza Tower, 4445 Calgary Trail South, Edmonton, Alberta, T6H 5C3.

Herb Rees, Research Station, Agriculture Canada, P.O. Box 20280, Fredericton, N.B. E3B 4Z7.

Harold Rostad, Saskatchewan Institute of Pedology, University of Saskatchewan, Saskatoon, Saskatchewan, S7N 0W0.

Laurens van Vliet, B.C. Pedology Unit, Agriculture Canda, 6660 N.W. Marine Drive, Vancouver, B.C. V6T 1X2.

Gregory J. Wall, Ontario Institute of Pedology, University of Guelph, Guelph, Ontario, N1G 2W1.

Attendance

British Columbia

G. Still	B.C. Forestry Service, Research Branch	Nelson
E. Kenk	Terrestrial Studies Branch	Kelowna
V. Hignett	Terrestrial Studies Branch	Victoria
B. Maxwell	Terrestrial Studies Branch	Kelowna
B. Mitchell	BCFS, Research	Kamlopps
A. Green	B.C. Pedology Unit	Vancouver
D.S. Pittlehouse	Dept. of Soil Science, U.B.C.	Vancouver
M. Sandheim	Ministry of Environment	Victoria
U. Wittneben	Terrestrial Studies Branch	Kelowna
I. Cotic	Soils Branch, Min. of Agriculture	Kelowna
J.P. Senyk	Lands Directorate	Victoria
D. Lacate	Lands Directorate, D.O.E.	Vancouver
H. Luttmerding	Soils, M.O.E.	Kelowna
A. McLeod	Min. of Forests	Prince George
T. Lord	L.R.R.I., Agric. Canada	Vancouver
L. Lowe	University of B.C.	Vancouver
G. Hope	B.C. Forestry Service	Prince George
J. Jungen	Terrestrial Studies	Kelowna
P. Epp	Terrestrial Studies	Kelowna
J.H. Wiens	Terrestrial Studies, Min. of Envir.	Victoria
P. Sanborn	Terrestrial Studies	Kelowna
R. Trowbridge	Ministry of Forests	Smithers
K. Valentine	L.R.R.I.	Vancouver
P. Christie	Ministry of Environment	Kelowna
H. Quesnel	Ministry of Environment	Victoria
L. Lavkulich	Dept. of Soil Science, U.B.C.	Vancouver
S. Chatwin	MacMillan Bloedel Ltd.	Nanaimo
S. Smith	MacMillan Bloedel Ltd.	Nanaimo
W. Watt	Ministry of Forests	Williams Lake
T. Ballard	Dept. of Soil Science and Forestry, U.B.C.	Vancouver
L. Van Vliet	L.R.R.I., Pedology Unit	Vancouver
A. Benson	Ministry of Environment	Victoria
N. Sprout	Ministry of Environment	Victoria
B. Louie	Ministry of Environment	Kelowna
H. Schreier	Dept. of Soil Science, U.B.C.	Vancouver
C. Selby	L.R.R.I.	Vancouver
E. Kenney	L.R.R.I.	Vancouver
D. Moon	L.R.R.I.	Vancouver
T. Vold	Terrestrial Studies, M. of Envir.	Victoria
M. Fenger	Terrestrial Studies, M. of Envir.	Victoria
T. Baker	Ministry of Forests, Research Branch	Victoria

Alberta

D. Pluth	Dept. Soil Science, University of Alberta	Edmonton
J. Tajek	Soil Survey	Edmonton
T. Brierley	Soil Survey	Edmonton

L. Turchenek	Soils Dept. Alberta Research Council	Edmonton
R. Wells	Soils Dept. Alberta Research Council	Edmonton
T. Macyk	Soils Dept. Alberta Research Council	Edmonton
W. Pettapiece	Soil Survey	Edmonton
W. Holland	Canadian Forestry Service	Edmonton
G. Patterson	Agric. Canada	Edmonton

Saskatchewan

L. Chambers	P.F.R.A.	Regina
D.F. Acton	Soil Institute of Pedology (S.I.P.)	Saskatoon
G.A. Padbury	S.I.P.	Saskatoon
D.W. Anderson	S.I.P.	Saskatoon
H.B. Stonehouse	S.I.P.	Saskatoon
H. Rastad	S.I.P.	Saskatoon
J. Stewart	S.I.P.	Saskatoon

Manitoba

B. Smith	Soil Science Dept. University of Manitoba	Winnipeg
P.W. Haluschak	Man. Soil Survey	Winnipeg
G. Mills	Man. Soil Survey	Winnipeg
W. Fraser	Soil Survey	Winnipeg
W.G. Zwarich	Dept. of Soil Science, U. of Manitoba	Winnipeg
R.G. Eilers	Man. of Soil Survey	Winnipeg
W. Michalyna	Man. of Soil Survey	Winnipeg
H. Veldhuis	Man. of Soil Survey	Winnipeg

Ontario

B. Kloosterman	L.R.R.I., Dept. of Agriculture	Ottawa
R.K. Jones	Ont. Institute of Pedology	Guelph
D. Coote	L.R.R.I.	Ottawa
C.J. Acton	Ont. Institute of Pedology	Guelph
J. Shields	L.R.R.I.	Ottawa
G. Coen	L.R.R.I.	Ottawa
M. Kingston	Ont. Institute of Pedology	Guelph
D. Aspinall	Ont. Institute of Pedology	Guelph
D. Schulman	Dept. of Nat. Resource, U. of Guelph	Guelph
P. Manlly	Dept. of Nat. Resource, U. of Guelph	Guelph
L.J. Evans	Dept. of Nat. Resource, U. of Guelph	Guelph
J. Day	L.R.R.I.	Ottawa
J. Jeglum	Canadian Forestry Service	Sault Ste. Marie
C. Tarnocai	L.R.R.I.	Ottawa
B. Gronas	L.R.R.I., Systems Consulting	Ottawa
G.J. Wall	Ont. Inst. of Pedology	Guelph
T. Taylor	Ont. Ints. of Pedology	Guelph
V. Timmer	Faculty of Forestry, U. of T.	Toronto
G. Pierpoint	M.N.R.	Maple
C. Wang	L.R.R.I.	Ottawa
R.J. Foulton	E.M.R.	Ottawa
P.J. Maharjan	Dept. of Agric.	Nepal

Quebec

J.M. Cossette	Agric. Canada, U. Laval	Ste Foy
R.W. Baril	Agric. Canada, U. Laval	Ste Foy

New Brunswick

J.K. MacMillan	N.B. Dept. of Agriculture	Fredericton
H. Rees	L.R.R.I., Atlantic Soil Survey	Fredericton
H. Krause	U. of New Brunswick	Fredericton

Nova Scotia

Ken Webb	L.R.R.I.	Truro

Newfoundland

A. Stewart	Soil Survey	St. John's