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# SOTER PROCEDURES MANUAL FOR SMALL SCALE MAP AND DATA BASE COMPILATION

## (For Discussion)



Compiled by J.A. Shields and D.R. Coote
Land Resource Research Centre
Under Contract to
The Glasod Project, ISRIC, The Netherlands

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Your file Votre référence

Our file Notre référence

February 10, 1988

Mr. Roel Oldeman
Project Manager GLASOD
P.O. Box 353
6700 AJ Wageningen
The Netherlands

Dear Roel:

Attached are the first 13 chapters of the SOTER Manual so you can commence translation. Dr. Coote will send the remainder of the Manual next week.

First, I must thank all the reviewers for their comments on the SOTER Procedures Manual draft received within the timeframe of our rather tight schedule. Reviews were received from Cochrane, Reybold (USDA), Sombroek, Oldeman, van de Wegg, Peters (ISRIC), Sehgal and Brabant. I also appreciated the supplemental information received from Reybold, Oldeman and Peters.

Collectively, the comments were very helpful and nearly all have been inserted to the revised text. I will briefly summarize the major revisions made and some major revisions suggested. Revisions of each of the following items were made in response to concerns by at least 2 or 3 reviewers:

1. Polygon File
   - 1.1. General Surface Lithology (Attribute 09).
     Revised to include a generalized description of the parent rock from which parent materials were weathered in place and other very general unconsolidated mineral or organic deposits. The more detailed parent materials originally included were deleted; they now occur only in the Terrain Component File.
   - 1.2. General Land Use/Vegetation (Attribute 12, now 14).
     The original number of classes were reduced and the FAO Vegetation Types (major headings only) were included.

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1.3. Surface Hydrology (Attribute 10)
Revised to include separate attributes for
- Permanent Lake Surface occupance, %
- Median distance between rivers and streams, km
- River and Stream Drainage Density estimated by comparison to standard diagrams showing low, medium or high density.

2. Terrain Component File

2.1. Ground (or Plant) cover (Attribute 16, now 18)
Revised to Predominant Land Use/Vegetation Type. Includes an expanded list of land use and vegetation type classes (FAO) in contrast to those given in the Polygon File.

2.2. Surface Flooding (Attribute 17, now 19)
Revised to Surface Flooding Classes due to Inundation and/or High Water Table in combination with duration classes.

2.3. Soil Drainage (Attribute 19)
Revised to Surface drainage or Run Off indicating the rate at which water drains from the surface in relation to the duration of waterlogging. Internal Soil Drainage was left in the Soil Attribute File.

3. Soil Layer File

3.1. Added 3 housekeeping fields to eliminate repetition of coding the same soil layer data already coded in a previous polygon (see revised fields 06, 10, 11). This repetition can be done by the computer.

3.2. Degree of Complexity (Attribute 06)
Was deleted because it was similar to variability attribute (25) in Terrain Component File.

3.2. Added Exchangeable Mn and classes and also P Fixation and classes, thanks to suggestions by Tom Cochrane.

4. Coding Forms

4.1 To expediate the coding procedure, each file attribute list (Polygon, Terrain Component, Soil Layer) and their respective class codes were summarized to one or two pages. These summaries are designed to provide the data compiler with rapid access to the codes to be entered on the Forms.

4.2 An example printout of coded soil layer data generated as a dBase Report is provided.

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5. Attention by reviews foccussed on the following items that have not been acted on.

   5.1. As suggested by Cochrane and Reybold, it will be necessary to decide on a standard 1:1 million base map on which to compile our maps. Does ISRIC have assess to this base map series?

   5.2 The need to address digitizing standards. This topic was not discussed at previous meetings. This need should be discussed at Montevideo.

   5.3 The need for inclusion of a Climatic Data file was suggested by Reybold, Cochrane and Oldeman.

As you are aware, the need for a separate Climatic Data File has been discussed only briefly at past meetings. However, to date no formal discussions have taken place to priorize the kind of climatic interpretations (or assessments) needed or to document the attributes required for the priority assessments.

In reviewing climatic attributes, it is apparent that two kinds occur, (1) primary (or basic) attributes such as minimum or maximum temperature and (2) secondary (or derived) attributes such as gowing season length. The list of primary attributes along with relevant meteorological station location and elevation data is relatively short. In fact this primary mean montly data has already been assimilated in CIAT's south American Meteorological Databasic (SAMMDATA) computer files as referred to by Cochrane et al., 1985.

To this point in time the SOTER Working Groups have documented a comprehensive legend for compilation of maps at 1:1 million scale and the attributes required for assessment of global soil degradation. The latter was achieved by a small Working Group assigned to priorize the kinds of degradation assessment required and which attributes were required to make those interpretations. Climatic assessment must be dealt with in a similar manner.

The concepts and procedures developed for climatic assessment should be compatable with those used in compiling the SOTER and Degradation attribute files. It is also necessary to establish if single factor isoline maps will suffice or if a climatic polygon map must be compiled. If crop production or land evaluation models are to be used, then the climatic and other input variable must be documented.

In view of the above it was decided not to proceed with supplementing climatic attribute files to the current SOTER Files. Instead, it is propopsed that climatic requirement be formally discussed at the Montevideo Meeting. It is suggested that Dr. Sombroek designate a small Working Group with Agmet expertise but also consisting of 1-2 members of the Legend and Degradation Groups to maintain continuity of established SOTER Concepts.

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In closing Dr. Coote and myself acknowledge and appreciate your invitation to attend the Montevideo Meeting. We will both attend. As suggested we have made our travel reservations. To qualify for reduced fare rates (about $2000 Canadian) we have to stay 7 days. We will arrive on March 18, and return on Friday, March 25, at 6:00 pm, (Coote can stay longer if necessary but not Shields). Please arrange for accommodation in Montevideo commencing Friday, March 18, and inform the hotel of the name and address.

Jack Shields

J. Shields
Land Resource Research Centre

Enclosures

JS/dr

PREFACE:

In January 1986, a group of approximately thirty scientists (soil and related disciplines) from around the world assembled in Wageningen, the Netherlands, under the sponsorship of ISSS with support from UNEP and others. From these Workshop recommendations, a proposal was written for the development of a World Soils and Terrain (SOTER) Digital Database at an average scale of 1:1 million. The list of possible interpretations tabled at this Workshop included:

Crop Suitability
Soil degradation
Irrigation Suitability
Forest productivity
Agroecological Zonation
Watershed management
Soil trafficability

A small committee was appointed to develop a "Universal" map legend dataset suitable for compilation of small scale soil-terrain maps at 1:1 M scale and to include the attributes required for the interpretations noted above. An initial list of attributes and their class limits was compiled. The SOTER proposal was further endorsed at the ISSS Congress in Hamburg, West Germany, August 1986.

A second meeting to discuss application of the SOTER data base was sponsored by UNEP and held in Nairobi in May, 1987. Two working groups (legend development and soil degradation assessment) met concurrently during this meeting. The legend working group was charged with the task to develop guidelines for a World soils and Terrain Digital Database at 1:1 million scale, to come forward with general legend concepts and definitions, to prepare an attribute file structure and to draft a tentative outline of a Procedures Manual. This task was completed and documented in the final report of the Ad Hoc Expert Group Meeting on Feasibility and Methodology of Global Soil Degradation Assessment, May, 1987, UNEP, Nairobi.

The Soil Degradation Assessment Working Group focussed on the definition of soil degradation, processes of soil degradation and global priorization of those processes: wind erosion, water erosion, salinization, alkalinization and chemical/nutrient decline. Data requirements of degradation assessment for both status and risk of these processes were listed and ranked for necessity (Mandatory, Desirable, Optional). For each of the processes it was recommended that the methodology developed should separate severity of degradation into four levels.

One of the major recommendations from this meeting was that status and risk assessment maps of soil degradation (wind erosion, water erosion, salinization) and essential attribute data be produced for five pilot areas in Third World countries; pilot areas in cooperating industrialized countries were also requested. Soils and terrain data for pilot areas will be entered into the SOTER database. It was also recommended that a detailed provisional Procedures Manual be prepared for development and use of the global soil and terrain digital database, including soil degradation assessment. As a follow-up of the Nairobi meeting, UNEP contracted ISRIC in Wageningen, The Netherlands, to compile a global map on the status of soil degradation at 1:10/15 Million, and to have it accompanied by a first pilot area at 1:1 Million scale in Latin America where both status and risk of soil degradation will be quantified on the basis of a digital soil and terrain data base at 1:1 Million scale under the terms of reference of this project code named GLASOD. ISRIC is to subcontract the preparation of the Procedures Manual for the 1:1 M level pilot study area.

## ACKNOWLEDGEMENT

Legend Working Group particpants at the Wageningen and Nairobi meetings are acknowledged for their contributions toward development of guidelines for a world soil and terrain digital data base at 1:1 Million scale, general legend concepts and definitions, attribute file lists and classes, and procedures manual outline:

R. Arnold
A. Ayoub
P. Brabant
T. Cochrane
M. Ilaiwi
B. MacDonald
J. Sehgal
J. Shields
W. Sombroek
R. Van de Weg

Participants of the Soil Degradation Assessment Working Group are also acknowledged for their contribution to sessions held at Nairobi Meeting towards definition of the term "soil degradation", priorizing processes of soil degradation, their kind of assessment and their data requirements:

M. Baumgardner
I. Garbouchev
M. Purnell
A. Raziq
G. Varallyay

SOTER Procedures Manual For Small Scale Map
and Data Base Compilation Including Proposed
Procedures (For Discussion) For Interpretation
Of Soil Degradation Status and Risk

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SOTER PROCEDURES MANUAL FOR SMALL SCALE MAP AND DATA BASE COMPILATION INCLUDING PROPOSED PROCEDURES (FOR DISCUSSION) FOR INTERPRETATION OF SOIL DEGRADATION STATUS AND RISK

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## INTRODUCTION

Soils differ dramatically in suitability for specific crops, response to different systems of management, carrying capacity, water holding capacity, internal drainage properties, and liability to degradation processes such as erosion, salinization and fertility decline. Throughout the world, especially in developing countries, land resource managers are constrained in their planning and decision making because of a critical lack of information about their soil and terrain resources. In cases where scientific data does exist, its effective exchange and transfer is also constrained by lack of standardization in describing and recording important resource information.

Preparation of a manual documenting small scale mapping procedures or procedures for compilation of small scale maps and attributes from existing larger scaled maps will serve to overcome the above constraints. It will be further beneficial if the data are compiled in a computer compatable format facilitating timely electronic analysis and retrieval of information.

Increasing pressure on land use intensity coupled with indiscriminate destruction of forests results in a spectre of soil degradation causing decreased productivity and adverse social consequences. It has been recently concluded that both ISSS and UNEP can benefit by collaboration in an assessment of global soil degradation. It has been recommended that status and risk assessment maps of priority degradation processes (wind erosion, water erosion, salinization, alkalinization, and chemical/nutrient decline) be produced for five pilot areas in Third-World countries.

Documentation of procedures for risk assessment of priority soil degradation processes from information compiled for small scale map attribute files will contribute significantly to knowledge on location and extent of different types of soil degradation. These procedures further contribute toward implementation of a comprehensive information system capable of delivering accurate, useful and timely degradation information to decision-makers concerned with development, management and conservation of environmental resources.

SHORT TERM OBJECTIVES:

1. To prepare a detailed Procedures Manual documenting standardized methods and descriptors to be used by all countries for compilation of a global soil and terrain (SOTER) digital database at an average scale of 1:1M. A "Universal" legend describing soil and terrain attributes will be designed to accomodate all major soil mapping and classification systems for entry to a computerized data base. It will also serve to minimize problems of correlation and quality controlled entry of information to the SOTER data base thereby ensuring its consistent application and interpretation. The manual will be based on the outline prepared by the Legend Working Group during the Nairobi Meeting in May/87.
2. To document selected polygon, terrain and soil attributes required for priority soil degradation interpretations, define their class limits and list them in a computer compatable format.

3. To document procedures for interpretation of data accumulated in the SOTER EXTENDED LEGEND at the 1:1M scale so that the present status of soil degradation may be assessed. The status of priority soil degradation problems of water erosion, wind erosion, salinization/alkalinization, and chemical/nutrient decline are the first to be assessed.
4. To document procedures for water and wind erosion risk assessment under conditions of bare, unprotected soils, as well as under the present vegetative cover. Different procedural options will be provided so as to permit users to select the procedure that best uses the available climatic data for their region. The SOTER data base will be the source of other relevant data.
5. To document procedures for assessment of the risk of salinization and/or alkalinization , and chemical/nutrient decline, using the SOTER data base.

## 2 GENERAL LEGEND CONCEPTS AND DEFINITIONS:

2.01 Major legend entries emphasize patterns of regional and local landforms, and parent rock/material.

2.02 Soil classification system is not a required major legend entry.

2.03 Each enclosed map delineation (or polygon) will be assigned a unique number as well as a map symbol. Polygons that have the same components (as regards surface form, slope, parent material and soil) constitute a mapping unit.

2.04 Major attributes which differentiate one compiled map polygon from another include:

| | |
|---|---|
| - local surface from | MANDATORY |
| - slope gradient class | MANDATORY |
| - parent rock/material | MANDATORY |
| - texture class (USDA) of soil parent material | MANDATORY |
| - general soil descriptive entry as agreed upon by the International Reference Base Group of ISSS | OPTIONAL |

These attributes are also shown by the map symbol and described in the map legend. The classes for these attributes are documented in the terrain component (surface form, slope, parent rock/material) and soil layer (texture) extended legend files.

2.05 Each polygon may include a maximum of 3 terrain components in which a terrain component is defined as a segment of the overall landform of a polygon with comparable, topographic (local surface form and slope gradient) and/or soil patterns.

2.06 For each terrain component at least one soil is characterized; a maximum of 3 soils may be characterized for each polygon. In cases where a polygon includes 2 terrain components, the mapper may choose to describe 2 soils applying to the first component and 1 soil applying to the second component. Furthermore, the mapper must indicate which soil applies to what proportion of the polygon.

2.07 Each soil may have a maximum of 4 "layers" in a continuum to a depth of 150 cm:

- 2 layers to about 50 cm
- 2 layers from about 50 cm to 150 cm

2.08 Each "layer" attribute has a "necessity requirement" designation of mandatory, desirable or optional.

2.09 Minimum size area of polygon should be about 1 cm x 1 cm.

2.10 Each polygon will be assigned a unique number and a map symbol.

2.11 Additional attribute information is documented in computerized files consisting of (1) polygon file (2) terrain component file and (3) a soil attribute file.

2.12 Information required for interpretation, such as climate, vegetation etc. will be accessed from other disciplines with compatible files.

2.13 In the absence of analytical data, an estimate by a qualified expert is acceptable and is referred to as the "Expert System". Expert System estimates should be documented as such.

2.14 The subject of acceptance of value data instead of class data in the attribute files was discussed briefly at the Nairobi meeting but no conclusion was reached. Therefore, since classes have been documented for all attributes, they will be used in this draft of the Procedures Manual.

# 3 GUIDELINES FOR MAP COMPILATION PROCEDURES USED WHERE MAPS EXIST

3.01 Maps are generalized (or compiled) from the most recently available published soil survey and other source maps.

3.01 Establish the size of area at the source map scale that reduces to 1 cm x 1cm at a scale of 1:1 million (large enough area to insert a map symbol). This is the smallest area you should map. Most areas will; of course, be larger. There are a few exceptions where a compiled map polygon at 1:1 million may be smaller than 1 cm x 1cm, such as:

- narrow elongated features and drainage patterns
- strongly contrasting soil or terrain areas

Map symbols can be attached to these polygons by use of a leader, assuming the polygon density adjacent to these areas has room for the extra symbol and leader.

3.03 Overlay and register transuluscent material with a matte surface to the source soil survey map.

3.04 Delineate the major drainage pattern, regional landforms (see Polygon File) and other major physiographic features on the source map. Care must be taken not to exaggerate the width of narrow elongated features to justify their inclusion on the map. These features often bisect larger areas with similar soil and terrain attributes which thereby greatly increases the number of polygons required.

3.05 Delineate large, uniform areas with similar differentiating terrain and soil attributes on the source map. Translate the source map symbol and legend information to the compiled map symbol format and assign a unique polygon number. A change in at least one differentiating attribute class limit on the source map results in a separate compiled polygon.

3.06 Where necessary, group smaller source map polygons which are most similar keeping in mind which attributes apply to the dominant (or most extensive) portion of the compiled polygon; translate its map symbol and assign a unique polygon number.

3.07 If necessary, group source map polygons which are dissimilar and proceed as indicated in item 3.05.

3.08 Continue the above procedure until most of the source map area is compiled. Review any remaining small areas and decide to which compiled polygons they should be most sensibly added.

3.09 Review the compiled polygons, their map symbols and source information (map legend and report) required for recording the attribute classes on the appropriate extended legend attribute file coding form; code attributes applying to the polygon, terrain component and soil layer attribute files.

3.10 Consideration should be given to adding any important agro-climatic or agroecological boundaries that are not yet coincident with map polygons delineated to this point. This will ensure continuity with future characterization of Agroecological Resource Areas.

3.11 Correlate polygon boundaries along adjacent source maps and also along International boundaries.

3.12 Reduce the compiled maps on the chronoflex overlays photomechanically to 1:1 million scale, process onto clear material, then register and mozaic to an appropriate base map. This mozaic is then recompiled for a pilot study area and edited.

During recompilation, it is recommended that Landsat imagery be used to help maintain overall project consistency and standardization of major physiographic and drainage features. Color composite 9 X 9 transparencies work well when used with a light table and their placement registered to the base map.

3.13 An island with a minimum size of 0.25 cm x 0.25 cm should be recognized and coded as a polygon.

3.14 If small islands are situated close together in a group, a line should be drawn around them to form a polygon. The portion of such a polygon which is water should be estimated and indicated as a percentage on the appropriate coding form.

3.15 Map Symbol Proposal - During previous working group meetings, there was no discussion on map symbols suitable for use on compiled maps. However, experience has shown during map compilation, it is convenient to record some of the most important differentiating polygon attributes on the map overlay in a concise symbol. The symbol provides a quick, readily available reference to selected attributes in addition to a unique polygon number. The following format is proposed:

| | |
|---|---|
| TOP LINE | Regional Landform, Number of Terrain Components, Soil Development |
| SECOND LINE | Parent Rock or Soil Parent Material and its soil texture group (general grouping of USDA soil texture classes into sand, loam, clay) |
| THIRD LINE | Local Surface Form, Slope |
| FOURTH LINE | Unique polygon number |
| EXAMPLE: | U 2 C<br>MO L<br>R 15<br>0001 |
| EXPLANATION: | The above symbol describes a polygon within a Upland(U) regional landform comprised of 2 terrain components dominated by Chernic(C) soils developed on morainal material(MO) of the loam texture group(L) with a rolling surface from form(R) and slopes of 15%, and a unique polygon number 0001. |

The codes for the above attribute classes are restricted to one or two characters to facilitate their use in the map symbol. Additional data are then coded to complete the respective polygon, terrain component and soil attribute files

## 3.16 Legend Concepts Reviewed.

During the above map compilation procedure, it is necessary to group source map polygons into larger polygons which have similar differentiating attributes thereby comprising a sensible consolidation of areas based on permanent natural occurring soil and terrain features. The guidelines in Section 2 on General Legend Concept indicate that each compiled polygon may have a maximum of 3 terrain components and that at least one soil is characterized for each component. A maximum of 3 soils may be characterized by layer (maximum of 4 layers) for each compiled polygon.

A maximum of 3 terrain components and a maximum of 3 soils characterized (or described) within a polygon encourages the compiler to be very selective in choosing those soils which are most important to the subsequent interpretations. To complete this selective process, it is important that the concept of a terrain component as defined earlier (Section 2.05) is clearly understood. That definition described a terrain component as a segment of the overall regional landform of a polygon with comparable topographic (local surface form and slope gradient) and/or soil patterns. Accordingly, it is implicit that the differentiating attributes of a terrain component include parent rock, soil parent material, its soil texture, local surface form and slope gradient. A significant change in any one of these attributes thereby results in a different terrain component as is indicated in the following examples.

Consider the case of a terrain component comprised of morainal material (MO) with loam texture(L), hummocky surface form (H) and slopes of 10%. The map compiler would like to describe 3 different soils occurring on quite different slope positions (summit, midslope, depression). It is permitted to describe up to 3 soils for one terrain component provided there is only one component within the polygon (see Case 1 below). However, if two terrain components occur within a polygon, as in Case 2 (fluvioglacial material with sand texture, undulating 4% slopes), one must choose carefully which soils from terrain component 1 are described along with the major soil from terrain component 2. The choice becomes even more critical in Case 3 where the polygon consists of 3 terrain components including lacustrine clay materials. In this latter case only the major soil occurring on each of the 3 different materials can be described.

| Case | Terrain Component Number | P.M. | Texture | Surface Form | Slope | Soil Description 1 (Slope Position) | 2 | 3 |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | Moraine | Loam | Hummocky | 10% | SUM | MID | DEP |
| 2 | 1 | M | L | H | 10% | | MID | DEP |
| | 2 | Fluvio-glacial | Sand | Undulating | 4% | | MID | |
| 3 | 1 | M | L | H | 10% | | MID | |
| | 2 | F | S | U | 4% | | MID | |
| | 3 | Lacust | Clay | U | 1% | | MID | |

It is suggested that the reviewers of this Manual add some typical examples of terrain components as defined herein from their local soil map areas; please include cases with 1, 2 and 3 terrain components occurring within a polygon. THE CONCEPT OF THE TERRAIN COMPONENT IS CENTRAL TO SOTER MAP COMPILATION, CORRELATION AND INTERPRETATION. WE MUST HAVE A UNIFIED CONCEPT THAT IS DEFINABLE, BASED ON MANDATORY REQUIREMENTS AND IS APPLICABLE TO MOST AREAS ON EXISTING MAPS.

The above legend concepts although somewhat restrictive provide sufficient flexibility to describe terrain components representative of permanent, naturally occurring soil and terrain attributes essential to satisfy the interpretive requirements.

Finally, it is also important to remember that it is not advisable to describe any more terrain components or soils than is necessary. Discretion at this point will save much time required for the coding and computer processing of extra data.

# 4. METHODOLOGY USED WHERE SOURCE MAPS AND DATA DO NOT EXIST

Little or no soil information is available for some areas where soil surveys are to be carried out in the future. Examples of these areas include northern Canada, parts of Africa, and parts of south America. In many cases, there is also a lack of geomorphological data concerning such features as regional landforms, surficial lithology and local surface forms. This lack of information which is sometimes coupled with inaccessiblity of terrain, requires development of a mapping methodology providing both detailed information on specific sites and general information in the form of small scale soil terrain maps based on LANDSAT imagery. Thus, the survey methodology used is different from that used in areas with existing source maps where small scale maps represent scaled down (or generalized) versions of the earlier source maps.

The field mapping procedures described below are taken from the experience described for exploratory mapping in Canada (Tarnocai, 1977) and from that documented in the Field Manual for Soil Mapping of India (Sehgal et al., 1987, of the National Bureau of Soil Survey and Land Use Planning, Nagpur). Both of the above utilized LANDSAT imagery coupled with traverses. In cases where cloud free satellite imagery is not available, it is necessary to use side looking radar imagery as reported by Cochrane et al. (1985) while mapping land in tropical America. The traverses may be by ground vehicle or by air where areas are inaccessible.

4.1 Mapping is carried out using 1:1M scale cloud-free, Landsat imagery of high quality which is interpreted manually. Multidate imagery is used if obtainable. If cloud free landsat imagery is not available, it is necessary to use side looking radar imagery.

4.2 Panchromatic photographs of the Landsat imagery may be used to aid manual interpretations.

4.3 Prefield activities include assembly of maps with accompanying reports dealing with topography, geomorphology, geology, climate, forestry (vegetation), soils and landuse of the area or part of it for study and use as aid to satellite image interpretation.

4.4 Prefield activities also include interpretation of satellite imagery employing a regional landform (or physiographic) approach including resource material listed in 4.3. Generally, bands 2 and 4 Landsat imagery are used for soil mapping. The bands used will depend on the imagery available.

4.5 Further interpretations are made on the basis of observeable local surface forms such as gullied, ridged, undulating or level.

4.6 Where areas are largely inaccessible by vehicle, systematic traverses are made by properly equipped fixed wing aircraft or by helicopter; periodic planned stops are made where possible. During these traverses, it is important to collect the maximum amount of information while in the air and during short ground traverses adjacent to the waterbody stops.

4.6.1 Information collected aerially (between stops) is mainly of use for interpreting satellite imagery. The most important features to observe include regional landforms, lithological materials, local surface forms, size and type of water bodies, vegetation patterns, land use patterns, and patterned ground features.

4.6.2 During stops, detailed information is collected relating to terrain, vegetation and landuse.

4.6.3 Soils are described and sampled on representative sites at these stops. This detailed soil and site information provides the basis for characterizing the association between soil and vegetation.

4.6.4 It is noteworthy that this is often the only data available for the soils, terrain and vegetation of the area. Therefore, the information must be collected quickly, efficiently and cost effectively by a soil surveyor experienced in the local environment.

4.7 Where areas are accessible by vehicle, a series of systematic ground traverses to compliment interpretation of satellite images are made. Bands 2 and 4 are used in combination with false color composites produced by a combination of bands 1, 2 and 4 with primary color filters of blue, green and red, respectively. The false color composite offers the interpreter an advantageous blend of contrasts that are easily identifiable even by a person not familiar with image interpretation.

4.8 Regional landforms are delineated on the satellite imagery based on interpretation of geomorphology, drainage pattern, vegetative cover and landuse. These polygons are further subdivided according to patterns indicative of specific local surface forms and unique image characteristics of tone, texture, color, etc., occurring simply or in combination. A unique polygon number is then assigned to each compiled polygon.

4.9 Three kinds of field transect activities are conducted to characterize the map polygons:

4.9.1 At grid point sites of 10 km intervals to provide general information on the soil population.

4.9.2 At sites within selected sample strips on an intensive scale. These strips are sampled to ensure the correct soil distribution composition within a map polygon. A minimum of about 20 observations is prescribed for a sample strip of 50 sq. km spread. The strips are selected on the basis of regional landforms and local surface forms delineations shown on the interpreted image. Strips are selected so all important and extensive polygons are covered.

4.9.3 Random observations.

4.10 Soil profiles are identified, described and sampled at all transect or random observation sites. Both site and soil morphological attributes are recorded according to national standards.

4.11 Soil samples are dried and passed through a 2 mm sieve until only coarse fragments remain. Both portions of sample are weighed to determine percentage of coarse fragments by weight.

4.12 Samples are submitted to the laboratory for analysis; national referencing standards are also analysed along with these samples.

4.13 Observations and information collected during transecting are used to assign a map symbol to each polygon.

4.14 Polygon boundaries and numbers are transferred from the satellite images to a topographic base at 1:1M scale which has planimetric accuracy.

4.15 SOTER Attribute files (see Section 11) are compiled pending receipt of the laboratory analysis data.

# 5. CORRELATION PROCEDURES FOR QUALITY CONTROL OF SOTER PROJECT AREAS

Soil correlation is the process of maintaining consistency of terminology and conventions during compilation of map and attribute data. It also includes assessment of the attribute classes and the compiled map polygons for interpretations.

In the correlation process, source map symbols and legends are examined for similarities and differences between differentiating attribute classes. The source map symbols and legend data must be interpreted consistently prior to their compilation (or grouping) into larger map polygons with common soil and terrain attributes which apply to most of the area enclosed.

Correlation begins with the planning phase of each pilot study area and continues through to the final report. It includes informal mapping decisions and quality control carried out by the project leader and other participants during map and attribute compilation (adapted from Expert Committee on Soil Survey Handbook, Vol. 2. 1985). It also includes the formal procedures called for in Correlog. Correlog as described herein is a log of correlation activities pertaining to these pilot study mapping requirements.

A detailed draft of the SOTER Legend is documented later in this Procedures Manual. As polygons, map symbols and legend attributes are reviewed during preliminary studies of an area, the information is assembled and used in correlation. Source Soil Map Legend descriptions and associated information in the report are used to group polygons with similar differentiating mapping attributes. As part of the continuing correlation process, periodic formal reviews are also conducted as described below.

To ensure that the correlation process functions quickly and efficiently, it is necessary that roles be clearly defined and responsibilities assigned. In addition to continuing correlation roles of compilers and the Project Leader, it is also required to designate a National Correlator and SOTER Correlators. The National Correlator is responsible for correlation among the map areas of a participating Country. The SOTER correlator is responsible for correlation of polygons and attributes along International Boundaries; a small correlation group with International experience should be established for this purpose.

Formal Reviews

As stated earlier, correlation activities of an informal nature continue from commencement to completion of a pilot study project. To compliment these activities, two distinct levels of progressive correlation activities are conducted more formally. The critical times chosen for these formal reviews are when 10% and 75% of the project map area and attribute compilation is completed. These are referred to as Correlation Levels 1 and 2. During these reviews, the Correlog Form (See following page) is filled out by the project leader in the presence of the SOTER (or International) correlator(s). This form is retained as record of progress toward objectives documented in the Project Plan. It also provides an opportunity to document problems encountered with the SOTER Legend and the actions required.

<u>Level 1 review</u> is conducted during the first or second months of active map and attribute compilation. It should occur as soon as is practical after the project leader has reviewed both SOTER and Source Map Legends. Level 1 is the most important review. It must be conducted on the perimeters of all adjacent maps (ie 1/10 width of map) from within a Country and between Countries. This is to ensure that all compilation participants are familiar with the SOTER legend files and the map compilation procedures documented in the SOTER Procedures Manual.

All queries and concerns must be addressed and resolved during this review so compilation can proceed quickly and efficiently. All polygon location and map symbol differences on adjacent maps must be resolved during this review. If inappropriate procedures or inadmissable attributes or symbols are not identified early in the project program, they tend to become entrenched thereby making adjustment to the errors more difficult. These discrepancies arise due to differences in source map scale, intensity of inspections and soil classification systems used. Reconciliation of these differences is achieved by carefully reviewing the source map legend and report information in the presence of compilers (map and attribute), National Correlators and SOTER Correlators. This review will take at least one-two weeks per project area.

<u>Level 2 review</u> is conducted after 75% of the project area including parts of all regional landforms in the pilot area have been completed. Its function is to ensure that compilation (map and attribute) has been done consistently and that all polygon map symbols and attribute files have been compiled according to SOTER Standards. It requires the presence of the

project leader, participating National correlators and at least one SOTER correlator. Deficiencies in the SOTER legend files should be documented and justifiable changes documented on a "correlation change sheet".

It is assumed that compilation for the remaining 25% of the project area can proceed with the required consistency and quality control of data. Any remaining correlation requirements will be considered as being essential to completion of the project.

CORRELOG FORM PROPOSED FOR SOTER PROJECT AREAS

Project Number:

Project Title:

Project Leader:

Participating National Correlator:

SOTER Correlator:

Data Correlog Conducted:

Correlation Level;.....

SOTER Procedures Manual Review Completed:

- Map Compilation Procedures;____Y, ____N
- Legend Attribute Files; ____Y, ____N

Plan is to compile map from source map;____Y, ____N

Source Maps and Reports Gathered;____Y, ____N

Source Maps and Reports Review Completed;____Y, ____N

Minimum size Map Delineation on Source Map when adjusted to 1:1M scale, cm x cm;.....

Training session by SOTER Correlator(s) Conducted; ____Y, ____N

Transparent overlay material accurately registered in place;_____Y, _____N

Perimeters (ie 1/10 of map width) of adjacent maps compiled, %;.....

Parts of each Regional Landform Compiled;____Y, ____N

Compiled Polygon Map Symbols in place; %.....

Compiled Polygon attribute files completed, %;....

Hard copy coding forms are available;____Y, ____N

Computer Hardware and Required Software is Functional;____Y, ____N

Computer Data File Compiled; ____Y, ____N

Differentiating Attributes of Compiled Map Polygons include:

- Regional Landform
- Parent Material/Rock
- Soil Texture
- Local Surface Form
- Slope Gradient

  Other, ______________

Differentiating Attributes of Terrain Component include:

- Parent Material/Rock
- Soil Texture
- Local Surface Form
- Slope Gradient

  Other, ______________

Differences in Compiled boundaries on adjacent source maps are resolved;____Y, ____N

Differences in attributes records for compiled polygon are resolved;____Y,____N

Compiled polygon boundaries are coincident with important

Agroclimatic or Agroecological resource area boundaries; ____Y, ____N

Additional boundaries indicative of Agroclimate are required; ____Y, ____N

Review of Attribute files for coding errors completed;____Y, ____N

Attribute files input to computer completed; ____Y, ____N

Source map overlays photoreduced to final scale;____Y, ____N

Reduced maps recompiled on final base;____Y, ____N

Air Photos being Utilized ____Y, ____N Scale (K);.....

Landsat(L) or Radar(R) imagery being utilized ____Y, ____N Scale (K);.....

Radar imagery being utilized; ______Y, ______N

Polygons covered by Air Traverse, % of area;.....

Polygons covered by Vehicle Traverse, % of area;.....

Planned transects complete,%.....

Planned Soil Sampling Complete, %;.....

Number of Soils Described;.....

Soil Analysis Complete, %;.....

Soil Description Entered to State/Prov Data File, %;.....

CORRELOG COMMENT SHEET TO BE COMPLETED BY PROJECT LEADER AND SOTER CORRELATOR:

1. Map polygons accord with current SOTER Map compilation procedures;____Y, ____N

2. Compiled map polygons are appropriate for planned interpretations;____Y, ____N

3. Small source map polygons of limited occurrence have been amalgamated with appropriate compiled polygons;____Y, ____N

4. Interpretation accuracy of source map symbols was observed to be acceptable;____Y, ____N

5. Interpretation accuracy of source map information to SOTER attribute files was observed to be acceptable; ____Y, ____N

6. Map Symbols are legible; ____Y, ____N

7. Resource material check list suggested to be available for Correlation Reviews:

   - Climate Data
   - Surficial Geology
   - Bedrock Geology
   - Bedrock Topography
   - Vegetation Cover
   - Topographic Maps

CORRELATION CHANGE SHEET FOR SOTER PROJECTS See Level 2 Review

# 6. SOTER ATTRIBUTE FILES AND CODING CONVENTIONS

Development of a world soil and terrain digital data base applicable to 1:1 M map scale requires organization of data into a series of computer compatable files. The first and shortest file includes only general attributes pertinent to the entire polygon hence the term Polygon file. Attributes in the second file describe the geomorphology, hydrology and the general soil conditions of each terrain component. The third and most comprehensive file provides detailed information on the soil, not only on its planar dimensions but also on its third dimension, depth; this file is referred to as the Soil Layer file. When complete, these three attribute files provide information required for many interpretations.

The above files can be defined into file structures compatible with dBASE or INFO software data base files. Thereby, the information when coded can be input to either data base management system for analysis, processing and retrieval in reports.

Each file consists of a number of attributes. The range of numeric values reported for each quantitative attribute has been subdivided into classes with defined limits. If the attribute is qualitative, descriptive classes are documented. This class data must be captured (or recorded) on coding forms. The format used for selecting attribute class codes essential to concise data capture is as follows:

1. NUMERIC CLASSES are designed to be connotative by recording the lowest value of the class (or range) except when the class commences with zero. In this case, record the number 1, or 0.1 or 0.01 as is appropriate to indicate that it is the lowest class. NOTE: In some cases, minor adjustments in class limits were made so that the lowest value of the class was 1.0, 2.0, 5.0 etc.

2. DESCRIPTIVE CLASSES are designed to be connotative by using the first 4 characters of the class name except in case of attributes shown in the map symbol (Regional Landform, Parent Material/Rock, Local Surface Form, Texture Group, Soil Development) where only 1 or 2 characters are permitted to facilitate a concise map symbol.
3. NOT APPLICABLE (#) is used when it is not relevant to record the attribute, i.e. it is not necessary to record soil drainage for hard rock material.
4. UNKNOWN (?) may be used for desirable or optional classes when no data is available. NOTE: If the attribute is mandatory, the values estimated by the expert system must be applied.
5. The above conventions ensure that information must be completed for every attribute record thereby facilitating easy editing for missing data. i.e. When editing, each blank field must be filled in.

# 7. SOTER POLYGON FILE ATTRIBUTE LIST AND STRUCTURE

| No. | Attribute Name | Type | Width |
|---|---|---|---|
| 01 | Country Code | CHAR | 4 |
| 02 | State/Province Code | CHAR | 2 |
| 03 | Base Map Code | CHAR | 4 |
| 04 | Report/Map Number Ref Code | CHAR | 4 |
| 05 | Polygon Number (unique) | CHAR | 4 |
| 06 | Regional Landform | CHAR | 1 |
| 07 | General Relief (median difference between highest/lowest), m | CHAR | 4 |
| 08 | Elevation, Median, m | CHAR | 4 |
| 09 | General Surface Lithology | CHAR | 4 |
| 10 | Permanent Lake Surface Occupance, % | CHAR | 2 |
| 11 | Seasonally Inundated Lands, % | CHAR | 2 |
| 12 | Median Distance Between Rivers and Streams, km | CHAR | 3 |
| 13 | River and Stream Drainage Density | CHAR | 1 |
| 14 | Predominant General Land Use | CHAR | 4 |
| 15 | Climate (refer to "separate file"). | | |

NOTE: Underlined characters (4) of attribute name key words are used to label attributes (or fields of information) on the coding forms.

# 8. SOTER POLYGON FILE ATTRIBUTE CLASSES, CODES AND DESCRIPTIONS

| | | |
|---|---|---|
| 01 | Country Code | - 4 Number International Code |
| 02 | State or Province Code | - 2 Number National Code |
| 03 | BASE Map Code | - 4 Character National Code |
| 04 | Report/Map Number Code | - 4 Number State or Province Code |
| | ? Unknown | |
| | # Not Applicable | |
| 05 | Polygon Number | - Number Code, Unique for each Map Poly |
| 06 | Regional Landform | - The general physical description (or shape) of the regional landform in contrast to its genetic origin or processes causing its shape. |

| Code | Class | Descriptions |
|---|---|---|
| M | Mountain Dominated | - Erosion and volcanic landscapes with relief (vertical distance between higher and lower parts) of at least 300 m with most of the area comprising valley to summit; slopes generally over 30%.<br>- A restricted summit area and steep sides, irregular shape and considerable bare rock surface, or very thin soil cover.<br>- Occur as a single, isolated feature or in a group forming a long chain or range. |

| | | |
|---|---|---|
| | | - Major scarps are the relatively steep and straight cliff-like slopes of considerable linear extent separating surfaces such as plateau lying at different levels. |
| H | Hill Dominated | - Natural elevations rising prominently above the surrounding plain and having a recognizably denser pattern of generally higher knolls or crest lines with an irregular or chaotic surface form composed of upper surface convexity and lower concavity<br>- Includes hummocky morainal material, volcanic cones, conical hills of lava built up around a volcanic vent<br>- Slope generally 10-30%<br>- Relief generally less than 100 m |
| T | Tableland (or Plateau) Dominated | - Comparatively flat areas of great extent commonly bounded on at least one side by an abrupt escarpment, or may be terminated by mountains.<br>- May be dissected by deep valleys and deeply incised rivers<br>- May be tectonic, residual or volcanic in origin |

| | | |
|---|---|---|
| | | - May be step-faulted<br>- Slopes generally less than 10%, occasionally 10-15%<br>- Relief generally less than 50 m. |
| P | Plain Dominated | - Flat to very gently undulating areas which have few or no prominent irregularities. They may be formed by erosion or by deposition processes<br>- Include broad continuous, gently sloping piedmont plains extending along and from the base of a mountain, formed by the lateral coalescence of a series of separate but confluent alluvial fans; alluvial processes are mainly responsible for the sedimentation. Coarse fragments are rounded by transport over relatively long distances.<br>- Slopes generally <6%<br>- Relief generally less than 10 m |
| V | Valley Dominated | - Comprise major spillways, drainageways or mountain trenches which are separated from surrounding landforms by a significant and abrupt break in slope. The valley profile |

| | | |
|---|---|---|
| | | may be V-shaped or U-shaped with an extensive valley floor. |
| U | Upland Dominated | - Surfaces of erosion and former accumulation which are undergoing erosional degradation processes of moderate to slight intensity. The dissections are mainly due to past erosion and only to a lesser extent to present erosion. The present surface is highly controlled by the underlying bedrock surface. Many flat to gently sloping remnants of the former original surface are still found. Major rivers are deeply incised.<br>- Includes dissected peneplains<br>- Slope generally <16%<br>- Relief generally <50 m |
| F | Footslope Dominated | - Include sloping area where debris carried mainly by slope wash are accumulating or have accumulated from adjacent mountains. Down movement is mainly by colluvial processes. Gravelly colluvial fans are included and also gravel covered pediments.<br>- Dissected lower slopes of major older volcanoes and mountains<br>- Upslope the ridges are narrow, |

valleys are deep and have very steep uniform slopes. Lower down the ridges are broad, flat-topped to rounded and are separated by steep valley.

- Slopes variable
- Relief up to 100 m

? Unknown

# Not Applicable

References for Regional Landforms include:

Kenya Soil Survey, 1978

Geoanalyses Limited, 1981

National Soils Handbook (USDA)

SCHEMATIC CROSS SECTIONS SHOWING DIFFERENT REGIONAL LANDFORMS

(NOT TO SCALE)



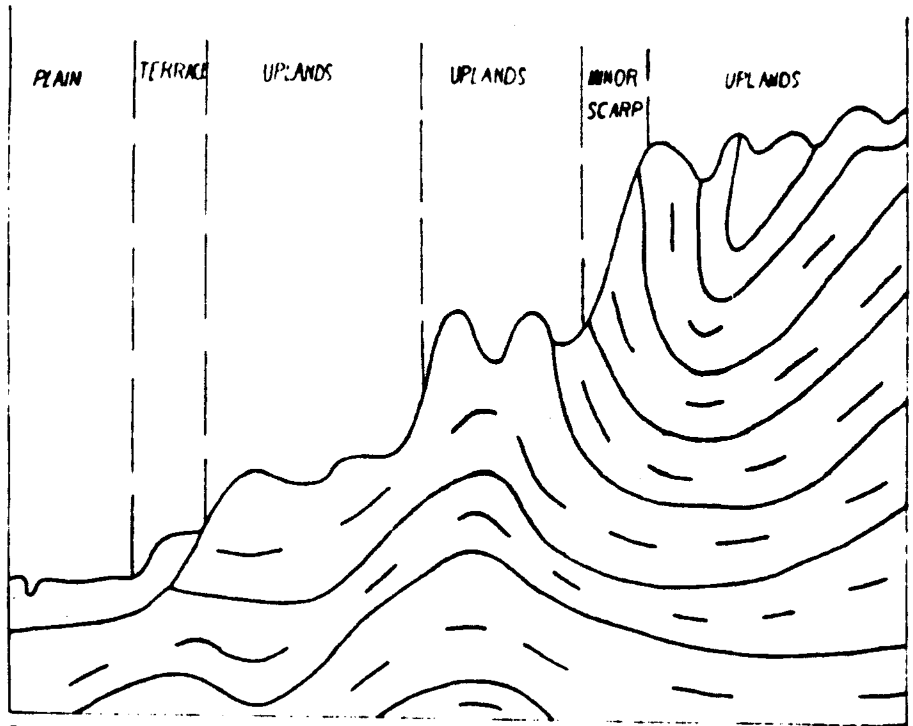



Fig 1

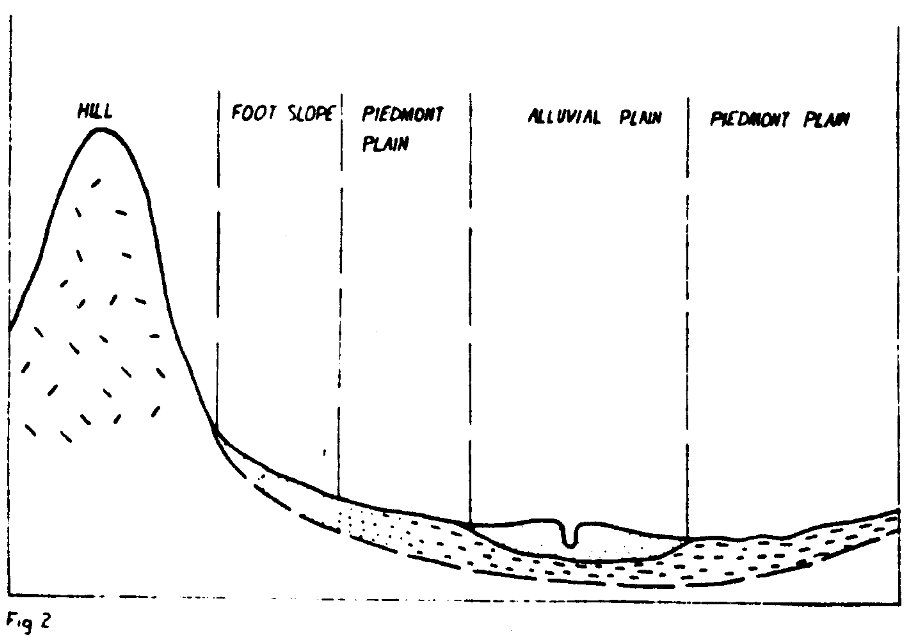



Fig 2

FROM KENYA SOIL SURVEY, 1978

# Regional Landforms

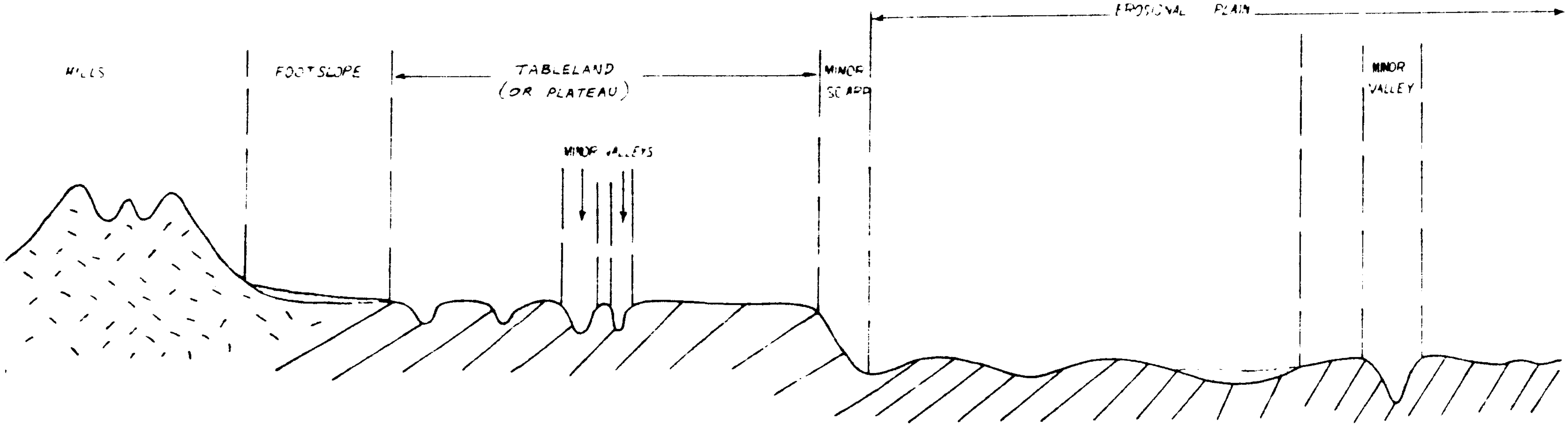




Fig 4

FROM KENYA SOIL SURVEY, 1978

# REGIONAL LANDFORMS

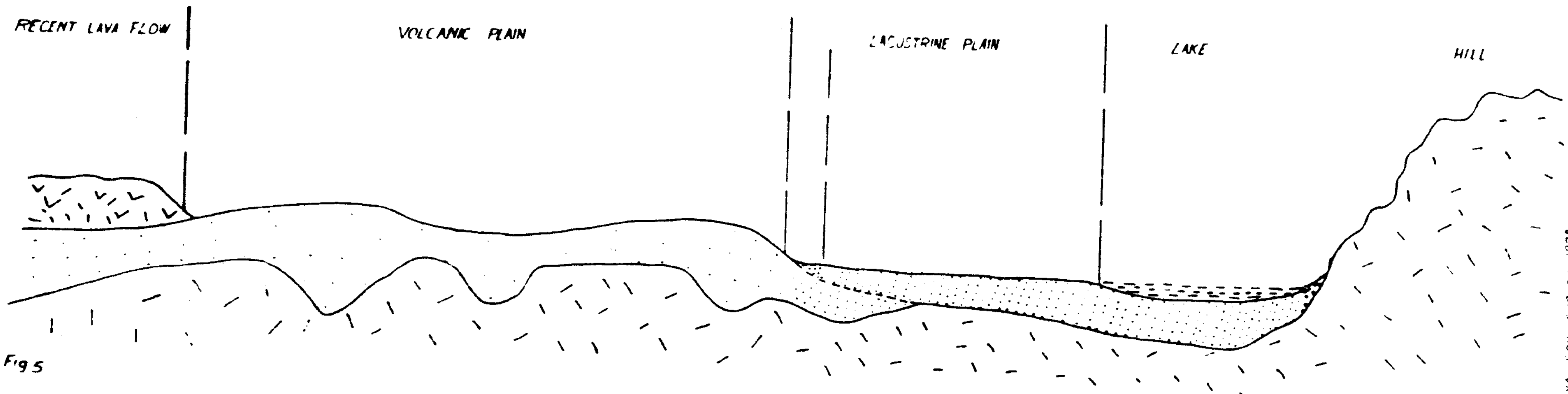



Fig 5

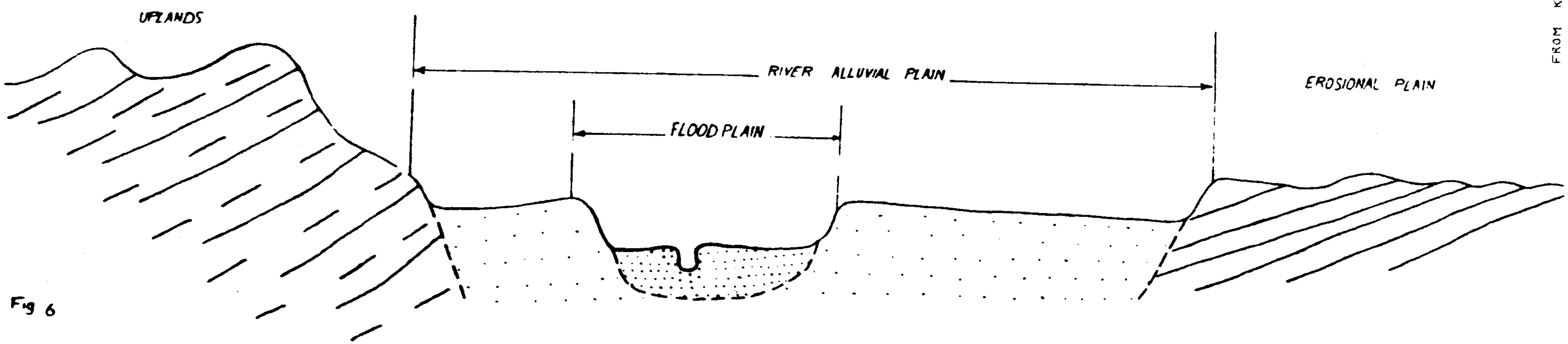
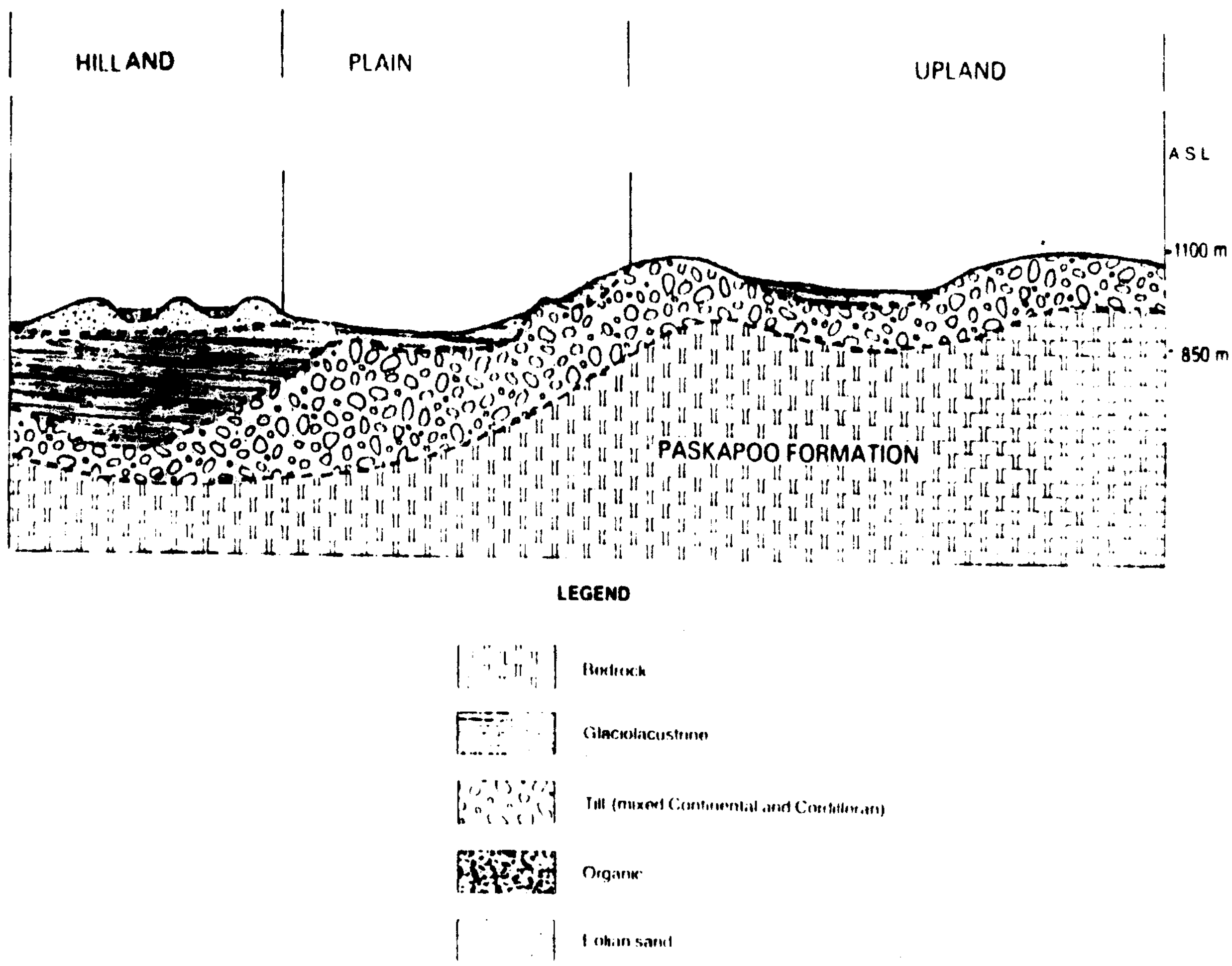



Fig 6

NOT TO SC

FROM KENYA SOIL SURVEY, 1978

# Regional Landforms.




from Brazeau Dam

# REGIONAL LANDFORMS



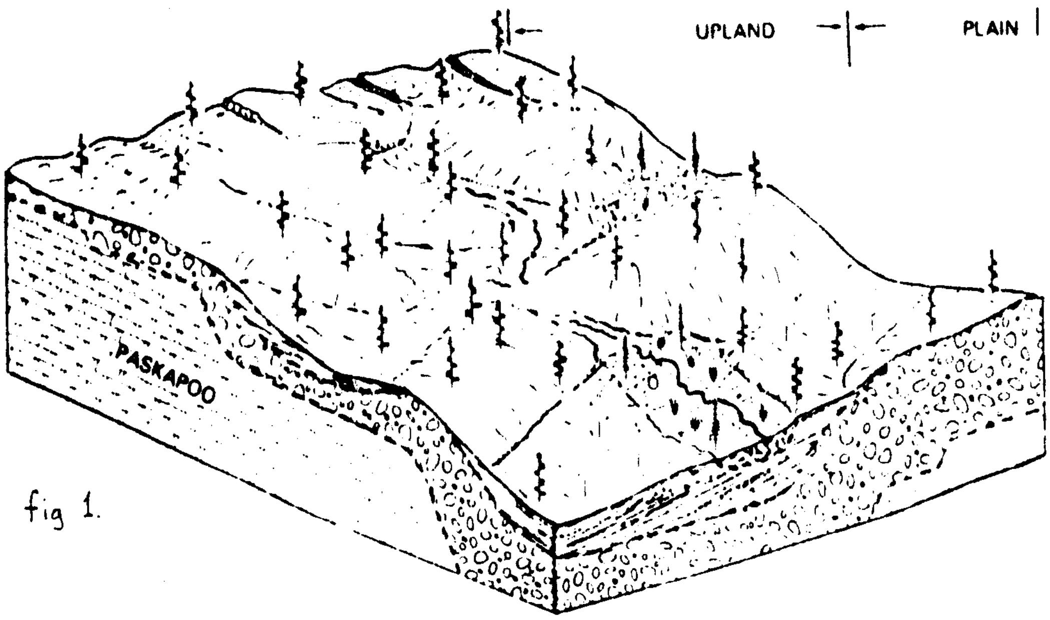



fig 1.

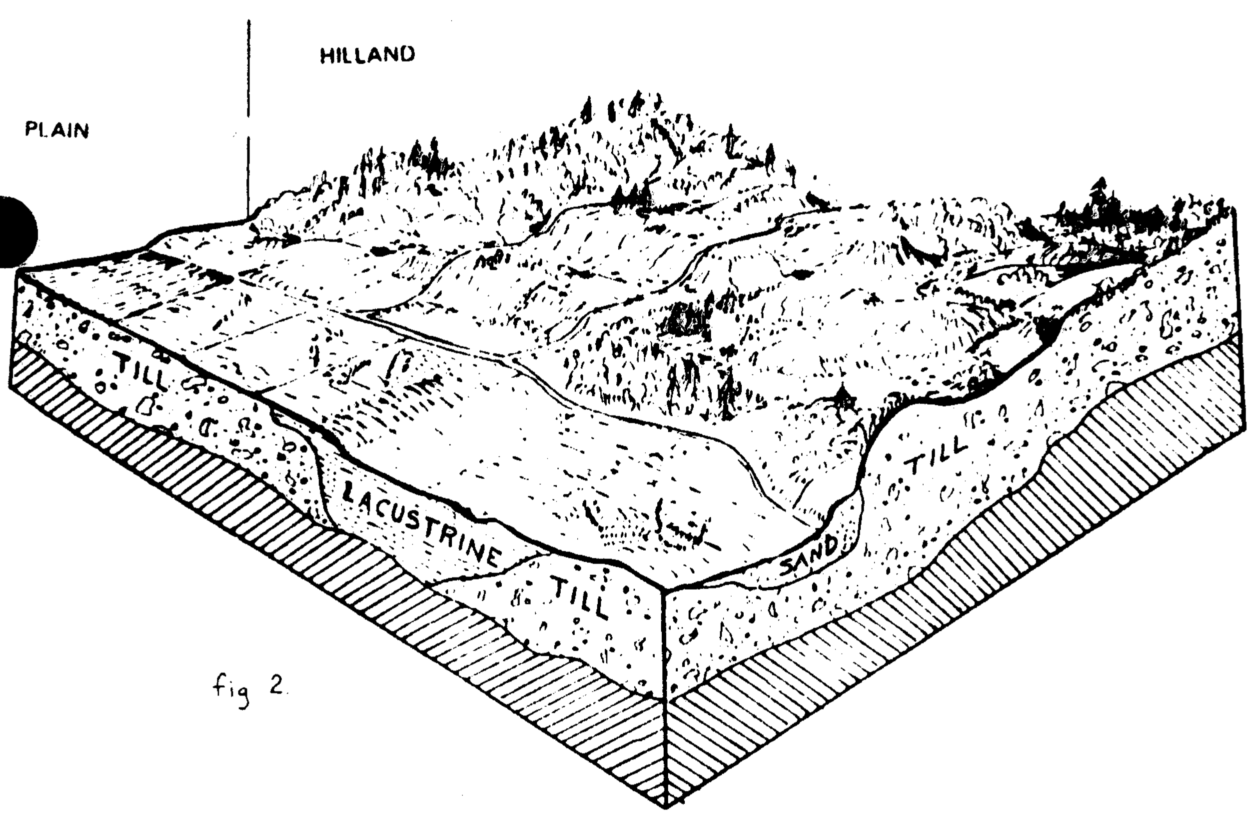



fig 2.

fig 1 from Brazeau Dam

fig 2 from Kocaoglu

07 General Relief (median difference between highest/lowest), Nearest 50 m

? Unknown

# Not Applicable

08 Elevation, Median, Nearest 100 m

? Unknown

# Not Applicable

09 General Surface Lithology - Generalized description of the consolidated or unconsolidated surficial materials which occupy most of the polygon. These materials include the kinds of rockmass from which parent material is derived and other unconsolidated mineral or organic deposits.

| Code | Class | | Description |
|---|---|---|---|
| IGNE | Igneous Rock | - | Formed by solidification from a molten or partially molten state; major varieties include plutonic and volcanic rocks. Examples: andesite, basalt, granite. |
| META | Metamorphic Rock | - | Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement at depth in the earth's crust. Nearly all such |

| | | | |
|---|---|---|---|
| | | | rocks are crystalline. Examples: schist, gneiss, quartzite. |
| SEDI | Sedimentary Rock | - | A consolidated deposit of clastic particles, chemical precipitates and organic remains accumulated at or near the surface of the earth under "normal" low temperature and pressure conditions. |
| SAND | Sandstone Rock | - | Sedimentary rock consisting of consolidated sands, grits, graywackes, and conglomerite. |
| SHAL | Shale Rock | - | Sedimentary rock consisting of shales (clays/silts with fine stratification), marls (calcareous mudstones), siltstones, mudstones (clays). |
| PYRO | Pyroclastic rock | - | Fragmental particles produced by usually explosive, aerial ejection of clastic particles from a volcanic vent either on land or under water. |
| MIXE | Mixed Rock | - | Mixture of any two or more of the above rock types. |
| UNSP | Unspecified rock | - | Unspecified |
| MARI | Marine | - | unconsolidated deposits of clay, silt, sand, or gravel that are well to moderately well sorted and well |

stratified to moderately stratified (in some places containing shells). They have settled from suspension in salt or brackish water bodies or have accumulated at their margins through shoreline processes such as wave action and longshore drift.

ALUV Alluvial

- Pertaining to sediment or processes associated with transportation and disposition by running water.
- Sediment generally consisting of gravel and sand with a minor fraction of silt and rarely clay. The gravels are typically rounded and contain interstitial sand. Alluvial sediments are commonly moderately to well sorted and display stratification.

EOLI Eolian

- Sediment, generally consisting of medium to fine sand and coarse silt particle sizes, that is well sorted, poorly compacted, and may show internal structures such as cross bedding or ripple laminae, or may be massive. These materials have been transported and deposited by wind action.

| | | |
|---|---|---|
| GLAC | Glacial Drift | - All rock material (clay, silt, sand, gravel, boulders) transported by a glacier and deposited directly by or from the ice or by running water emanating from a glacier. Drift includes unstratified material (till) that form moraines, and stratified glaciofluvial deposits that form outwash plains, eskers, kames and glaciolacustrine deposits. |
| COLL | Colluvial | - Massive to moderately well stratified, nonsorted to poorly sorted sediments with any range of particle sizes from clay to boulders and blocks that have reached their present position by direct, gravity-induced movement<br>- They are restricted to products of mass-wasting whereby the debris is not carried by wind, water, or ice (excepting snow avalanches). |
| RESI | Residuum | - Unconsolidated, weathered, or partly weathered mineral material that accumulates by disintegration of bedrock in place. |

| | | |
|---|---|---|
| UNDI | Undifferentiated | - A layered sequence of more than three types of unconsolidated genetic material outcropping on a steep erosional escarpment. This complex class is to be used where units relating to individual genetic materials cannot be delimited separately at the scale of mapping. |
| ORGA | Organic | - Organic materials known as peat, muck, bog or swamp that are commonly saturated with water for prolonged periods. They contain 17% or more organic C by weight. |
| ICE | ICE | - The ice component includes areas of snow and ice where evidence of active glacier movement is present within the boundary of the defined unit area. This movement will be indicated by features such as crevasses, superglacial moraines, icefalls, and ogives. The assumed process status is active. |

10. Permanent Lake Surface Occupance, %

11. Seasonally inundated lands, %

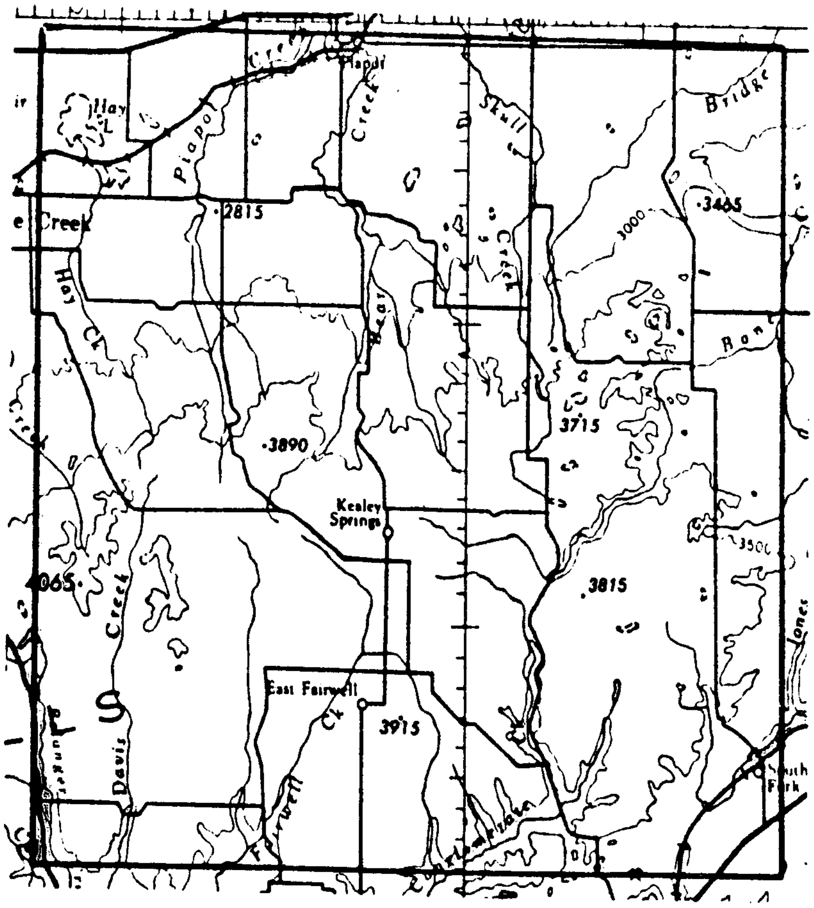
12. Median Distance between rivers, streams and lakes, km

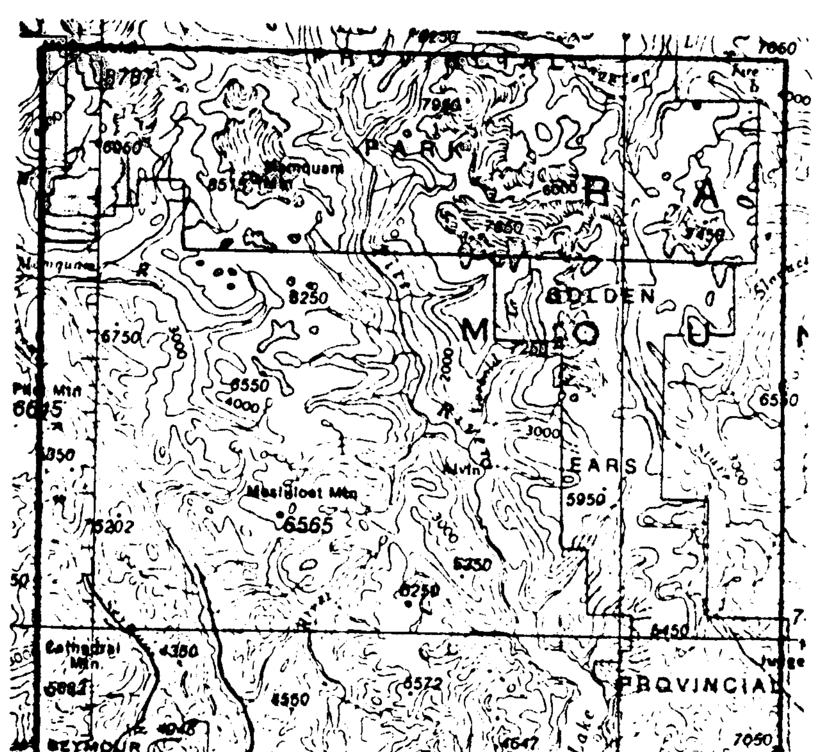
13. River and Stream Drainage Density, estimated by comparison to standard reference areas.

14 Predominant General Land Use/Vegetation Type

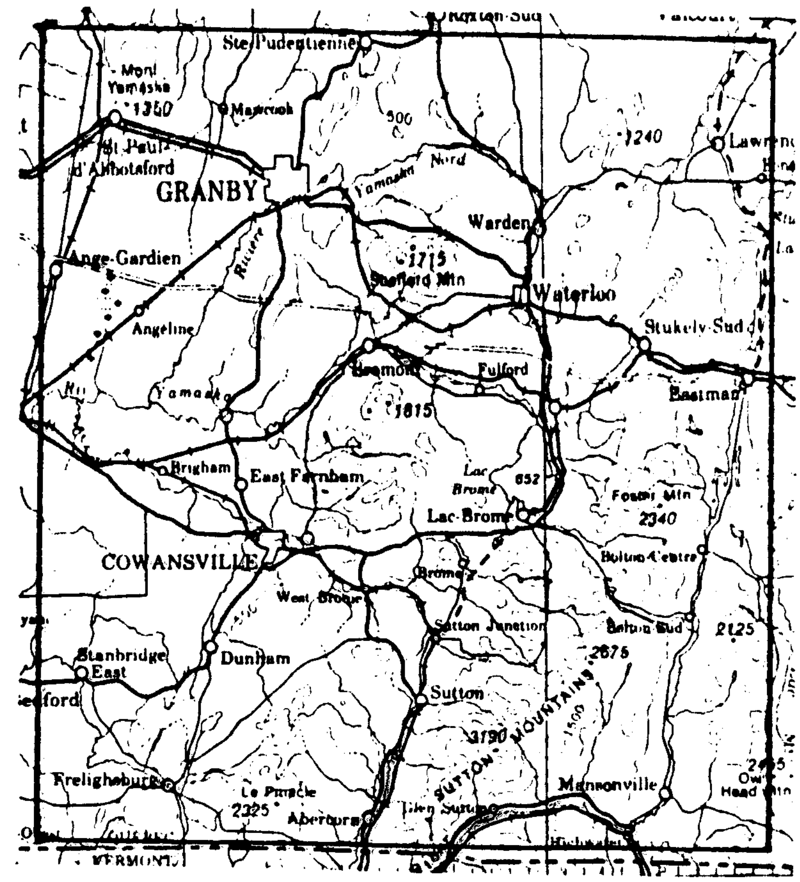
| Code | Class |
|---|---|
| ANNU | Annual Cropland |
| PAST | Pastureland which is Cultivated |
| GRAS | Grassland, which is Native |
| SHIF | Shifting Cultivation in Forest Covered Land |
| FORE | Forestland, Closed Stand |
| PLAN | Plantation Land |
| ORCH | Orchard Land |
| ROCK | Rockland or Rubble Land |
| DESE | Desert Land |
| ORGA | Organic Swamp, Bog, Fen |
| TUND | Tundra |
| IRRI | Irrigated Land |
| WOOD | Woodland (Open Stand of Trees) |
| SHRU | Shrubland |
| DWAR | Dwarf Shrubland |
| ? | Unknown |
| # | Not Applicable |

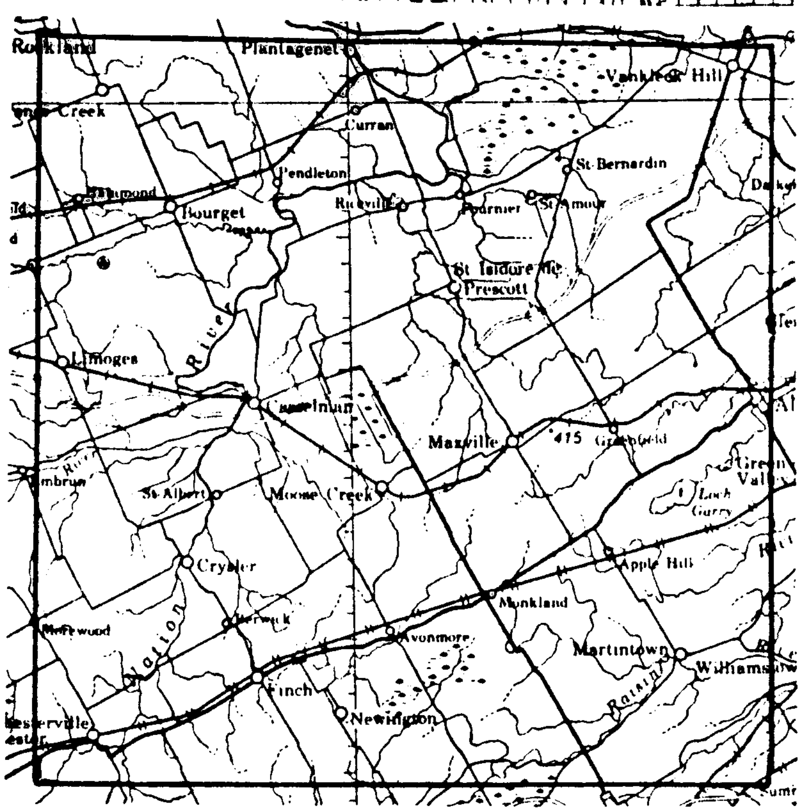
# Low Density River and Stream Drainage



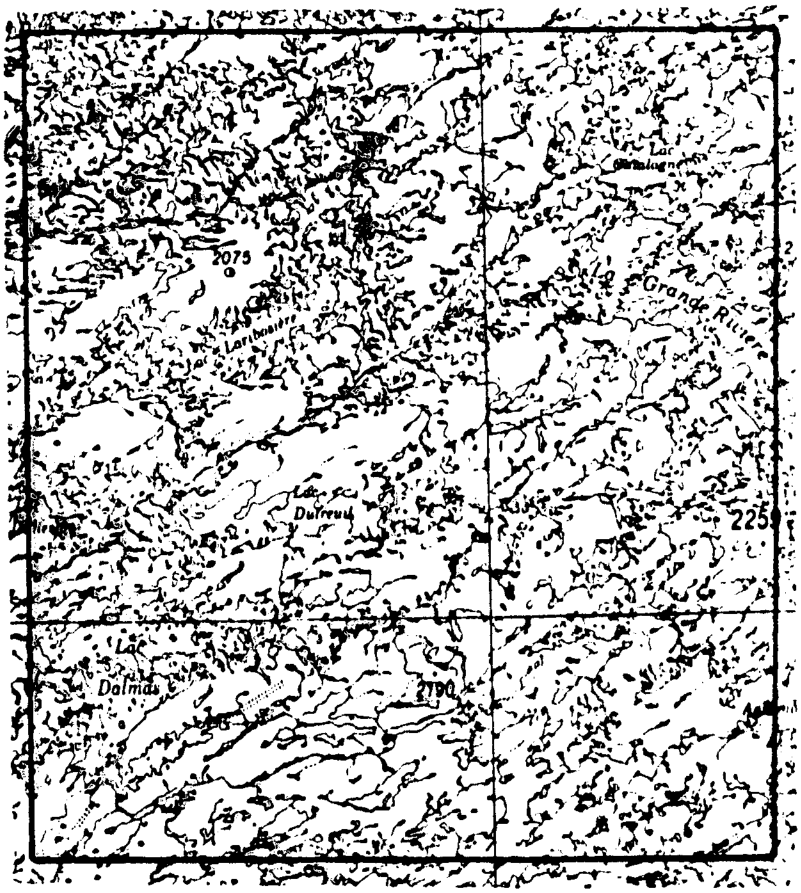



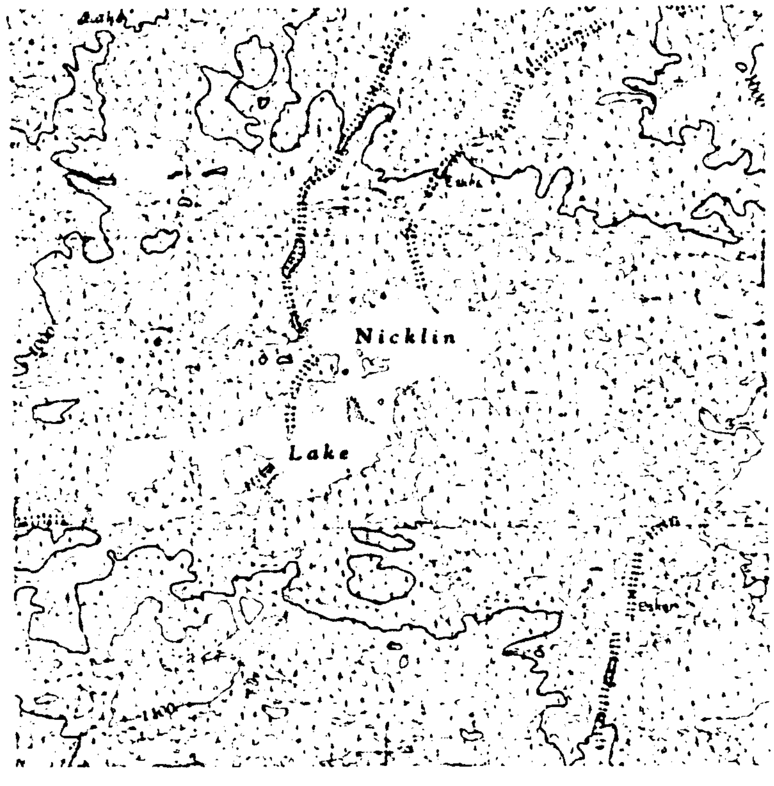
# MEDIUM DENSITY RIVER AND STREAM DRAINAGE



HIGH DENSITY RIVER AND STREAM DRAINAGE



9. SOTER TERRAIN COMPONENT FILE ATTRIBUTE LIST AND STRUCTURE

| No. | Attribute | Type | Width | Dec |
|---|---|---|---|---|
| 01 | Country Code | CHAR | 4 | |
| 02 | State/Province Code | CHAR | 2 | |
| 03 | Base Map Code | CHAR | 4 | |
| 04 | Report/Map Number Reference Code | CHAR | 4 | |
| 05 | Polygon Number (unique) | CHAR | 4 | |
| 06 | Proportion of Polygon to which following attributes apply, nearest 10% or 5% when needed | NUMERIC | 2 | |
| 07 | Terrain Component Number | CHAR | 1 | |
| 08 | Parent material/Parent rock | CHAR | 2 | |
| 09 | Texture Group of Parent Material | CHAR | 1 | |
| 10 | Local Surface Form | CHAR | 1 | |
| 11 | Slope Gradient, % | CHAR | 2 | |
| 12 | Length of Slope, m | CHAR | 3 | |
| 13 | Stoniness at Surface | CHAR | 4 | |
| 14 | Rockiness Outcrops | CHAR | 3 | |
| 15 | Depth to Ground Water, cm | CHAR | 5 | |
| 16 | Quality of Ground Water, micro mho | CHAR | 4 | |
| 17 | Rooting Depth which is Unrestricted, cm | CHAR | 3 | |
| 18 | Predominat Land Use/Vegetation Type | CHAR | 2 | |
| 19 | Surface Flooding Due to Inundation | CHAR | 3 | |

| No. | Attribute | Type | Width | Dec |
|---|---|---|---|---|
| 20 | Propensity to Surface Crusting or Sealing or Surface Cracking | CHAR | 4 | |
| 21 | Surface Drainage | CHAR | 4 | |
| 22 | Overwash with Recent Water Erosion Products | CHAR | 2 | |
| 23 | Overblow with Recent Wind Erosion Products | CHAR | 2 | |
| 24 | Water Erosion, Status | CHAR | 1 | |
| 25 | Wind Erosion, Status | CHAR | 1 | |
| 26 | Complexity of Parent Material/Soil | CHAR | 1 | |
| 27 | Permafrost Distribution | CHAR | 1 | |
| 28 | Ice Content of Materials | CHAR | 1 | |

NOTE: Underlined characters of attribite name key words are used to label attributes (or fields of information) on coding forms.

# 10. SOTER TERRAIN COMPONENT FILE ATTRIBUTE CLASSES, CODES AND DESCRIPTIONS

01 Country Code - 4 Number International Code

02 State or Province Code - 2 Number National Code

03 Base Map Code - 4 Character National Code

04 Report/Map Number Code - 4 Number State or Province Code

? Unknown

# Not Applicable

05 Polygon Number - 4 Number Code, Unique for each map Polygon

06 Proportion of Polygon to Which the Following Attributes Apply, Nearest 10% (i.e. 50%, 30%), or 5% When Needed (i.e. 15%)

07 Terrain Component Number - A maximum of 3 per polygon (i.e. 1,2,3)

08 Soil Parent Material/Parent Rock - Parent rock or material derived from parent rock

| Code | Class | Description |
|---|---|---|
| AL | Mineral Alluvial | - Sediment generally consisting of gravel and sand with a minor fraction of silt and rarely clay. The gravels |

| | | |
|---|---|---|
| | | are typically rounded and contain interstitial sand. Alluvial sediments are commonly moderately to well sorted and display stratification. Examples: channel deposits, overbank deposits, terraces, alluvial fans, and deltas. |
| CO | Mineral Colluvial | - Massive to moderately well stratified, nonsorted to poorly sorted sediments with any range of particle sizes from clay to boulders that have reached their present position only by direct, gravity-induced movement (excepting snow avalanches).<br>- Processes include slow displacements such as creep and solifluction and rapid movements such as earth flows, rockslides, avalanches, and falls. |
| EO | Mineral Eolian | - Sediment, generally consisting of medium to fine sand and coarse silt particle sizes, that is well sorted, poorly compacted, and may show internal structures such as cross bedding or ripple laminae, or may be massive. Individual grains may be rounded and show signs of frosting. These materials have been transported |

| | | |
|---|---|---|
| | | and deposited by wind action. |
| | | - Examples: dunes, shallow deposits of sand and coarse silt, and loess but not tuffs. |
| FL | Mineral Fluvio-glacial | - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers, and kame terraces. |
| LA | Mineral Lacustrine | - Sediment generally consisting of either stratified fine sand, silt, and clay deposited on the lake bed or nearshore moderately well sorted, stratified sand transported and deposited by wave action. |
| | | - These are materials that either have settled from suspension in bodies of standing fresh water or have accumulated at their margins through wave action. |
| | | - Examples: lake sediments and beaches. |

| | | |
|---|---|---|
| MO | Mineral Morainal | - Sediment generally consisting of well-compacted material that is nonstratified and contains a heterogeneous mixture of sand, silt and clay particle sizes in a mixture that has been transported beneath, beside, on, within, and in front of a glacier and not modified by any intermediate agent.<br>- Examples: basal till (ground moraine), lateral and terminal moraines, rubbly moraines of cirque glaciers, hummocky ice-disintegration moraines, and preexisting, unconsolidated sediments reworked by a glacier so that their original character is largely or completely destroyed. |
| AN | Mineral Anthropogenic | - Man-made or man-modified materials, including those associated with mineral exploitation and waste disposal.<br>- They include materials constructed by man or geological materials modified by man so that their physical properties (structure, cohesion, compaction) have been drastically altered. |

| | | |
|---|---|---|
| | | - Examples: areas of landfill, spoil heaps, open-pit mines, levelled irrigated areas. |
| UN | Mineral Undifferentiated | - A layered sequence of more than three types of genetic material outcropping on a steep erosional escarpment. This complex class is to be used where units relating to individual genetic materials cannot be delimited separately at the scale of mapping. It may include colluvium derived from the various genetic materials and resting upon the scarp slope. |
| MA | Mineral Marine | - Unconsolidated deposits of clay, silt, sand, or gravel that are well to moderately well sorted and well to moderately well stratified (in some places containing shells). They have settled from suspension in salt or brackish water bodies or have accumulated at their margins through shoreline processes such as wave action and longshore drift. Nonfossiliferous deposits may be judged marine, if they are located in an area that might reasonably be |

| | | |
|---|---|---|
| | | considered to have contained salt water at the time the deposits were formed. |
| MR | Mineral Marl | - An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal proportions. |
| RE | Mineral Residuum | - Unconsolidated, weathered, or partly weathered soil mineral material that accumulates by disintegration of bedrock in place. |
| OB | Organic, BOG | - Sphagnum or forest peat materials (>30% organic matter by weight) formed in an ombrotrophic environment due to the slightly elevated nature of the bog tending to be disassociated from nutrient-rich ground water or surrounding mineral soils.<br>- Near the surface the materials are usually undecomposed (fibric), yellowish to pale brown in color, loose and spongy in consistence, and entire sphagnum plants are readily identified. These materials are extremely acid, with low bulk density |

and very high fiber content. At depths they become darker in color, compacted, and somewhat layered.

- Bogs are associated with slopes or depressions with a water table at or near the surface in the spring and slightly below it during the remainder of the year. They are usually covered with sphagnum mosses, but sedges may also grow on them. Bogs may be treed or treeless and are frequently characterized by a layer of ericaceous shrubs.

OF Organic, FEN

- Sedge peat materials (>30% organic matter by weight) derived primarily from sedges with inclusions of partially decayed stems of shrubs formed in a mineotrophic environment due to the close association of the material with mineral-rich waters.
- It is usually moderately well to well decomposed, dark brown to black in color, with fine to medium sized fibers; decomposition often becomes greater at lower depths.

| | | |
|---|---|---|
| | | - The materials are covered with a dominant component of sedges, but grasses and reeds may be associated in local pools. |
| OS | Organic Swamp | - A peat-covered or peat-filled (>30% organic matter by weight) area with the water table at or above the peat surface. The dominant materials are forest and fen peat formed in a eutrophic environment due to strong water movement from the margins or other mineral sources.<br>- It is usually moderately well to well decomposed and has a dark brown to reddish brown matrix; the more decomposed materials are black in color. It has an amorphous or very fine fibered structure containing a random distribution of woody fragments and trunks of coniferous tree species.<br>- The vegetation cover may consist of coniferous or deciduous trees, tall shrubs, herbs, and mosses. In some regions sphagnum mosses may be abundant. |

| | | |
|---|---|---|
| OU | Organic Undifferentiated | - A layered sequence of more than three types of organic material. |
| CA | Rock, Crystalline, Acid | - Any igneous rock predominantly consisting of light-colored materials, having low specific gravity and having more than 65% silica ($SiO_2$) Examples: granite, granodiorite aplite, rhyolite |
| CB | Rock, Crystalline, Basic | - Any igneous rock having a relatively low silica content, sometimes delimited arbitrarily as less than 54%. They are relatively rich in Fe-Mg minerals such as pyroxenes (augite), horneblend, nephelinite, gabbro, norite, dolerite, pyroxene, serpentinite, peridotite. |
| SN | Rock, Sandstone | - Sedimentary rock consisting of consolidated sands, grits, graywackes, and conglomerite. |
| SH | Rock, Shales | - Sedimentary rock consisting of shales (clays/silts with fine stratification), siltstones, mudstones (silt and clays). |

| | | |
|---|---|---|
| LI | Rock, Limestone | - Sedimentary rock consisting of limestone, coral reef limestones or travertines. |
| SA | Rock Schist, Acid | - Schist rocks from acid environment. |
| SB | Rock Schist, Basic | - Schist rocks from basic environment |
| GA | Rock Gneiss, Acid | - Gneiss rocks from acid environment |
| GB | Rock Gneiss, Basic | - Gneiss rocks from basic environment |
| EA | Rock Effusive, Acid | - Pyroclastic rocks from acid environment |
| EB | Rock Effusive, Basic | - Pyroclastic rocks from basic environment. |
| RU | Rock Unspecified | - Rock of unspecified origin and properties |
| IC | ICE | - The ice component includes areas of snow and ice with evidence of active glacier movement.<br>- Examples: cirque glaciers, mountain icefields, valley and piedmont glaciers. |
| WA | Water | |
| ? | Unknown | |
| # | Not Applicable | |

References for general surface lithology including parent material:

CanSIS Manual, 1982 Revised.

Kenya Soil Survey, 1978

Canadian Wetland Classification System, 1987.

09 Texture Group of Parent Material

| Code | Class | Group of USDA Soil Texture Classes |
|---|---|---|
| X | Extremely Sandy | - Includes all sand texture classes. |
| S | Sandy | - Includes all loamy sand, and sandy loam texture classes and their gravelly or cobbly modifiers. |
| L | Loamy | - Includes all loam and clay loam texture classes and their gravelly or cobbly modifiers. |
| C | Clayey | - Includes clay texture class up to 60% clay and their gravelly or cobbly modifiers. |
| Y | Very Clayey | - More than 60% clay. |

10 Local Surface Form - A description of the physical surface form (assemblage of slopes) or recurring pattern of forms occurring at the earths surface. Form as

applied to consolidated materials, form refers to the product of their modification by geological processes. (Canadian System of Soil Classification, 1978)

Mineral Surface Forms:

| Code | Class | Description |
| --- | --- | --- |
| G | Gullied | - A well developed pattern of frequent, deep gullies providing external drainage for the area. |
| H | Hummocky | - A very complex sequence of slopes extending from somewhat rounded depressions or kettles of various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls or depressions. Slopes are generally 4-70%. Examples: hummocky moraine, hummocky glaciofluvial. |
| I | Inclined | - A sloping, unidirectional surface with a generally constant slope not broken by marked irregularity or gullies. A weakly developed dissected pattern provides external drainage for the local area. Slopes are 4-60%. The form of inclined slopes is not related to the initial |

| | | |
|---|---|---|
| | | mode of origin of the underlying material. |
| L | Level | - A flat or very gently sloping, unidirectional surface with a generally constant slope not broken by marked elevations and depressions. Slopes are generally less than 2%. Examples: floodplain, lake plain, some deltas. |
| R | Rolling | - A very regular sequence of moderate slopes extending from rounded, sometimes confined concave depressions to broad, rounded convexities producing a wavelike pattern of moderate relief. Slope length is often 1.6 km or greater and gradients are greater than 5%. This surface form is usually controlled by the underlying bedorck. |
| E | Ridged | - A long, narrow elevation of the surface, usually sharp crested with steep sides. The ridges may be parallel, subparallel, or intersecting. |

| | | |
|---|---|---|
| | | Examples: eskers, crevasse fillings, washboard moraines, some drumlins. |
| S | Steep | - Erosional slopes greater than 60%, on both consolidated and unconsolidated materials. The form of a steep erosional slope on unconsolidated materials is not related to the initial mode of origin of the underlying material.<br>- Examples: escarpments, river banks, and lakeshore bluffs. |
| U | Undulating | - A very regular sequence of gentle slopes that extends from rounded, sometimes confined concavities to broad rounded convexities producing a wavelike pattern of low local relief. Slope length is generally less than 0.8 km and the dominant gradient of slopes is usually less than 6%, but may range up to 8%. Examples: some drumlins, some ground moraine, lacustrine material of varying thickness over morainal deposits. |

| | | |
|---|---|---|
| T | Terraced | - Scarp face and the horizontal or gently inclined surface (tread) above it.<br>Example: alluvial terrace. |
| C | Gilgai | - A microrelief pattern consisting of a succession of enclosed micro-basins and micro-knolls up to 60 cms in nearly level areas or of micro-valleys and micro-ridges that run with the slope. Gilgai microrelief patterns occur on clay soils that have high coefficients of expansion and contraction with changes in moisture (USDA Handbook 18) |
| M | Mounded | - A pattern including distinct mounds of varying relief rising above a planar surface. The mounds must occupy at least 40% of the area.<br>Example: termite mounds. |
| A | Apron | - A relatively gentle slope at the foot of a steeper slope and formed by materials from the steeper, upper slope. |

| | | |
|---|---|---|
| | | Examples: two or more coalescing fans, a simple slope. |
| ? | Unknown | |
| # | not Applicable | |

ORGANIC Surface forms (Canadian Wetland Classification System, 1987)

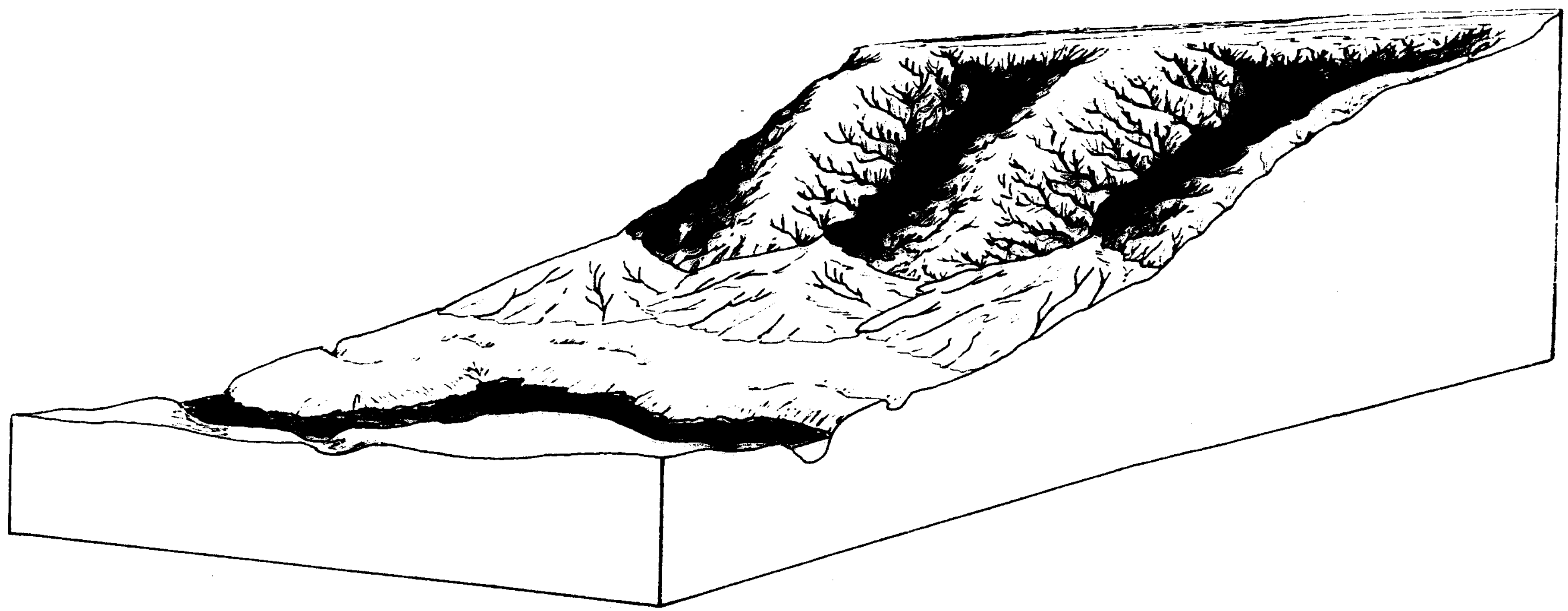
| Code | Class | Description |
|---|---|---|
| B | Blanket Bog | - A bog consisting of extensive peat deposits that occur more or less uniformly over gently sloping hills and valleys. The peat thickness seldom exceeds 2 m. |
| D | Domed Bog | - A large (usually more than 500 m in diameter) bog with a convex surface, rising several metres above the surrounding terrain. The centre is usually draining in all directions. Small crescentic pools often form around the highest point. Peat development is usually in excess of 3 m. |

| Code | Class | Description |
|---|---|---|
| F | Flat Bog | - A bog having a flat, featureless surface. It occurs in broad, poorly defined depressions. The depth of peat is generally uniform. |
| P | Plateau Bog | - A raised bog elevated 0.5-1 m above the surrounding fen. It is usually teardropshaped, with the pointed end oriented in the downslope direction. |
| V | Veneer Bog | - A bog occurring on gently sloping terrain generally underlain by discontinuous permafrost. Although drainage is predominantly below the surface, overland flow occurs in poorly defined drainage-ways during peak runoff. Peat thickness is usually less than 1.5 m. |
| J | Ribbed Fen | - A fen with parallel, low peat ridges ("strings") alternating with wet hollows or shallow pools, oriented across the major slope at right angles to water movement. The depth of peat exceeds 1m. |

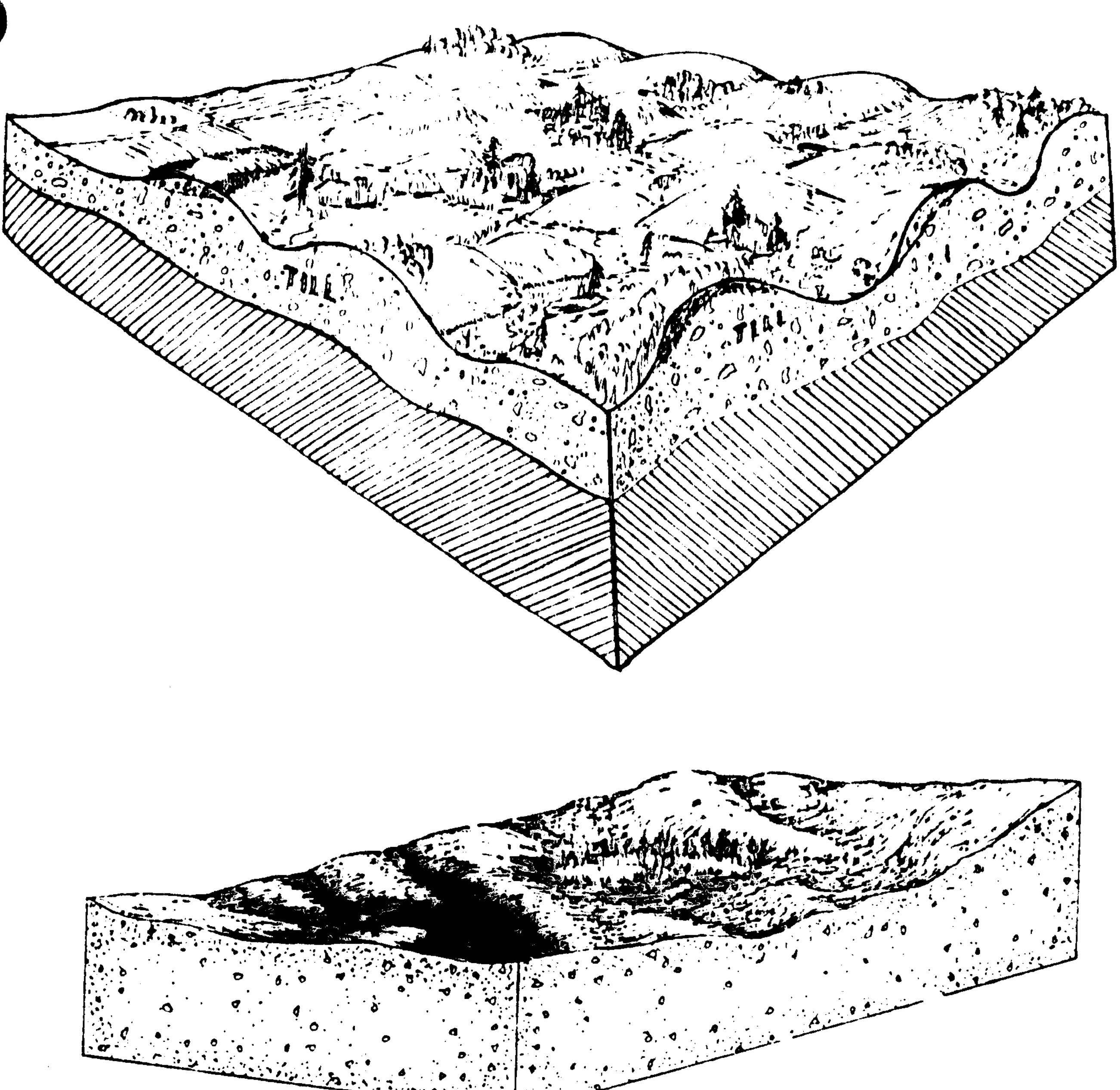
| Code | Class | Description |
| --- | --- | --- |
| K | Horizontal Fen | - A fen with a very gently sloping, featureless surface. This fen occupies broad, often ill-defined depressions, and may be interconnected with other fens. Peat accumulation is generally uniform. |
| N | Delta Marsh | - A marsh occupying lowlands on deltas, usually with drainage connections to active river channels. It is subject to inundation at least once during a season, followed by a slow drawdown of the water levels. A high rate of sedimentation may occur in many parts of the marsh. |
| O | Coastal Marsh | - A marsh influenced by brackish or saline waters of tidal marine origin. It is located above mean high-water levels and is inundated only by flood tides. It occurs on marine terraces, flats, embayments, or lagoons. |

| Code | Class | | Description |
|---|---|---|---|
| Q | Floodplain Marsh | - | A marsh occurring on fluvial floodplains adjacent to river channels. The marsh is subject to annual flooding and sedimentation for various lengths of time, with possibly some water impounded on the marsh following flooding. |
| W | Floodplain Swamp | - | A swamp occurring in a valley which may be inundated by a seasonally flooding river. Slow drawdown after flooding preserves a high water table for most of the growing season. Shallow peat development may be encountered. |
| X | Basin Swamp | - | A swamp developed in a topographically defined basin where the water is derived locally but may be augmented by drainage from other parts of the watershed. Accumulation of well-decomposed peat is shallow (less than 0.5 m) at the edge, and may reach 2 m at the centre. |

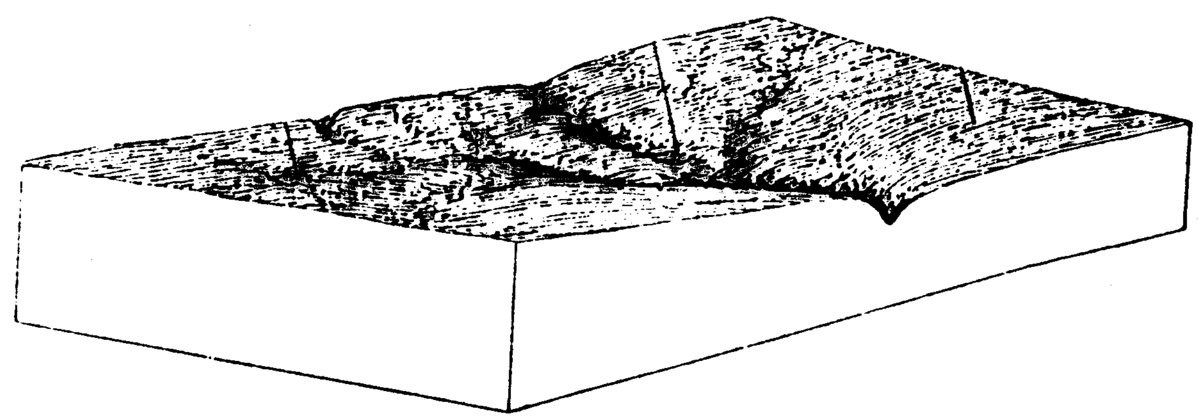
GILGAI SURFACE FORM



GULLIED SURFACE FORM



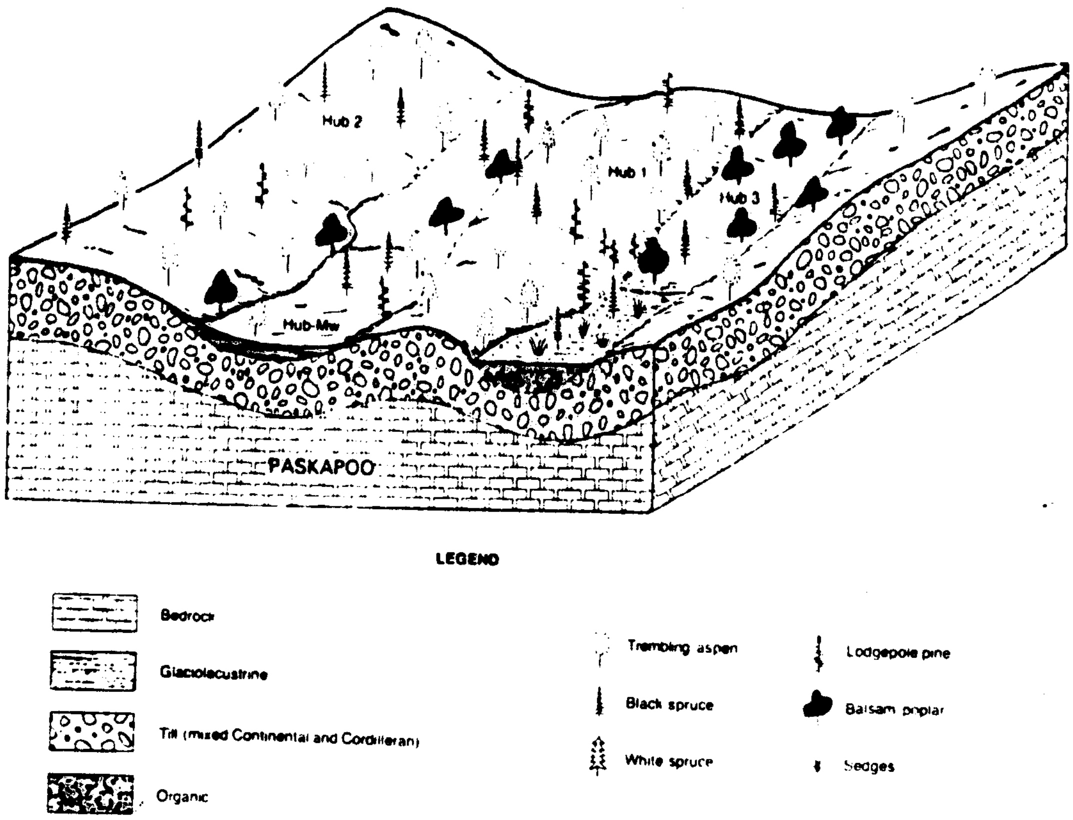

HUMMOCKY SURFACE FORM

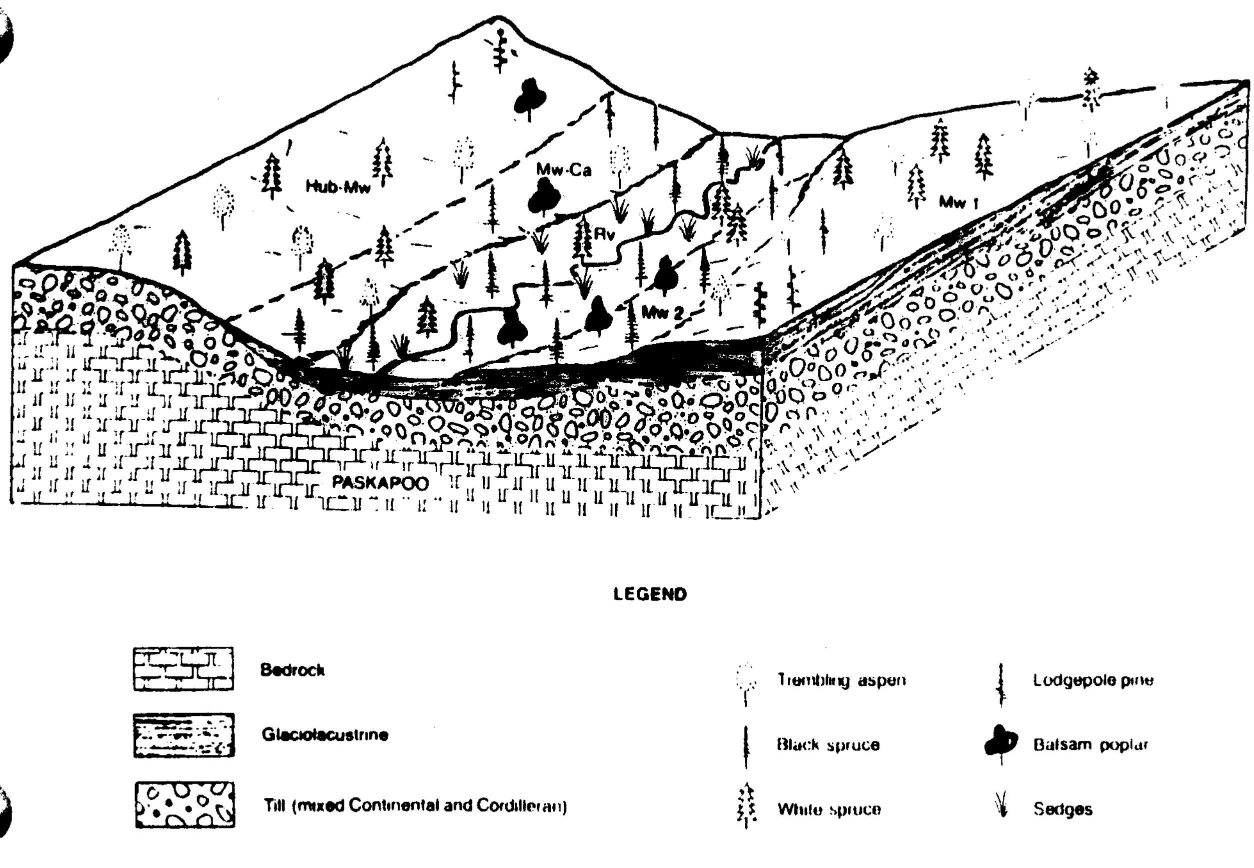


INCLINED SURFACE FORM

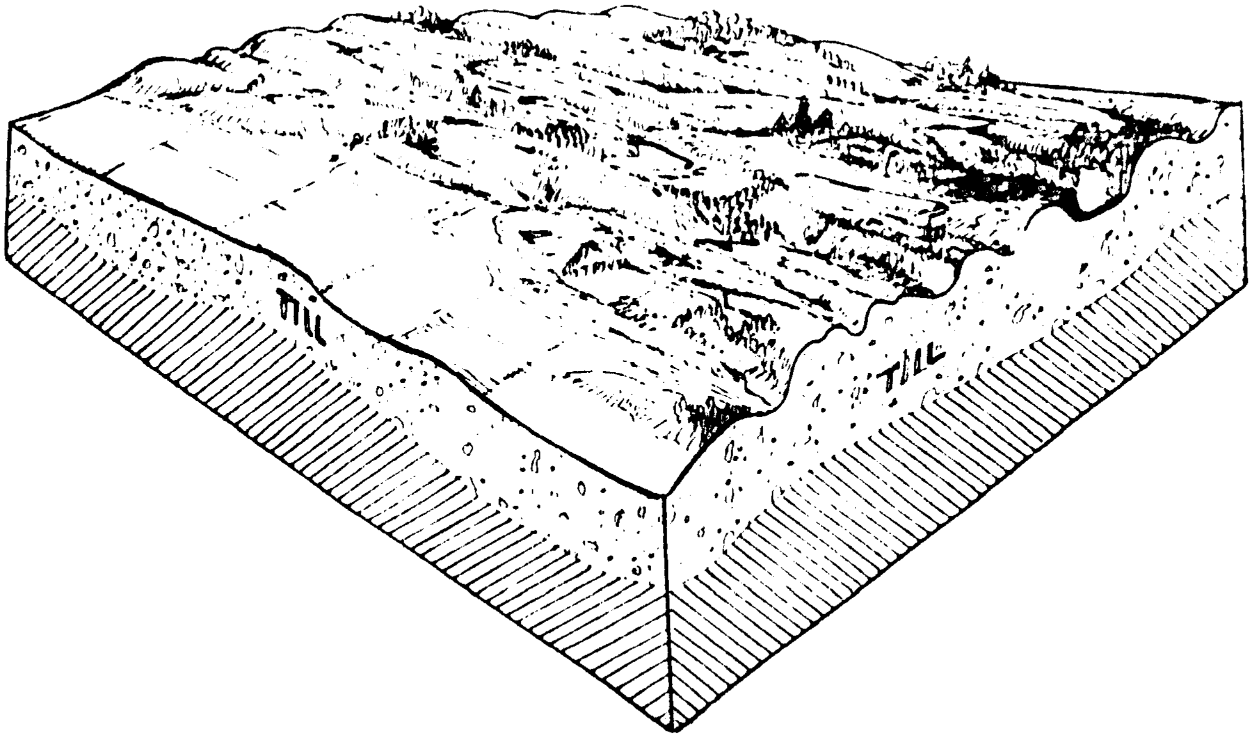
LEVEL

Steep surface form



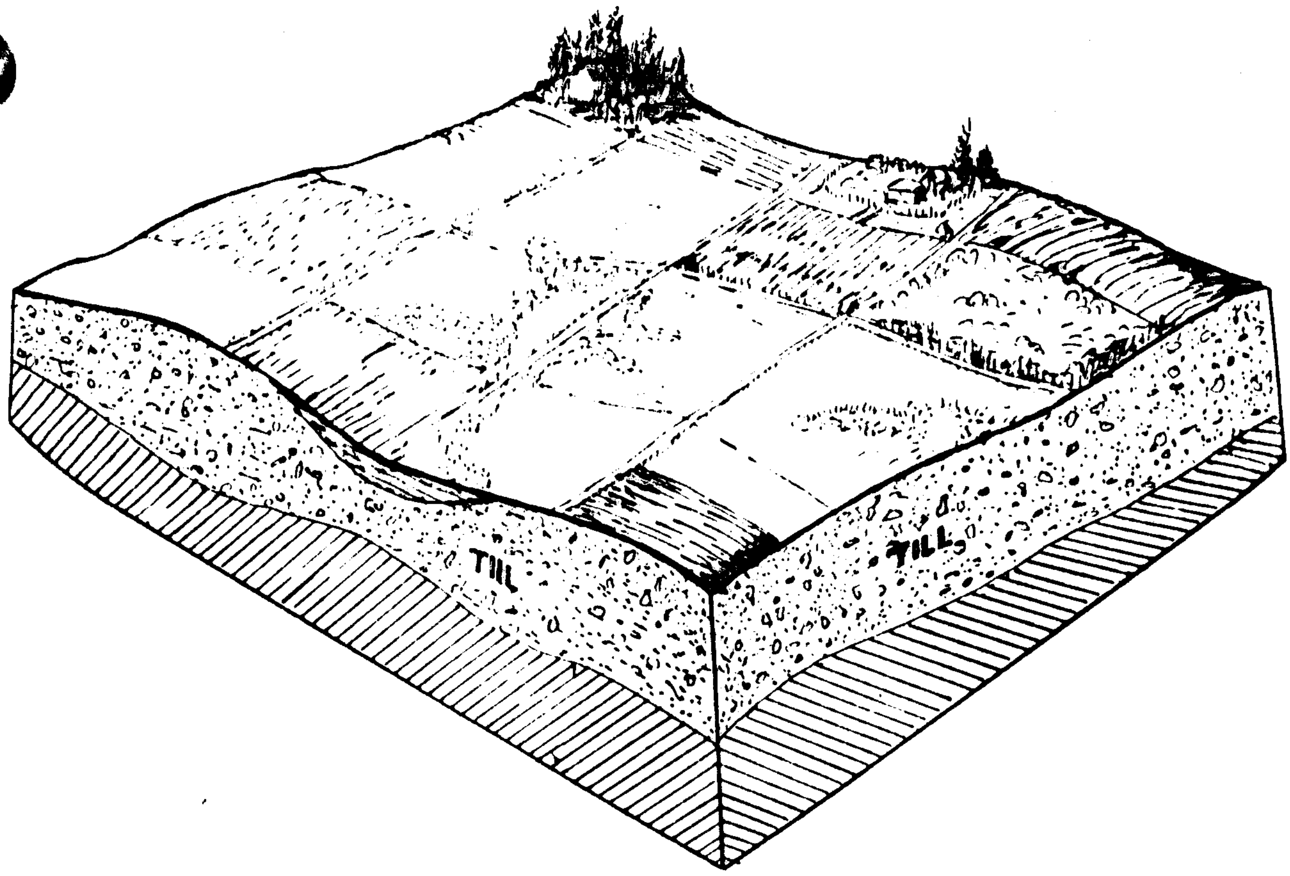



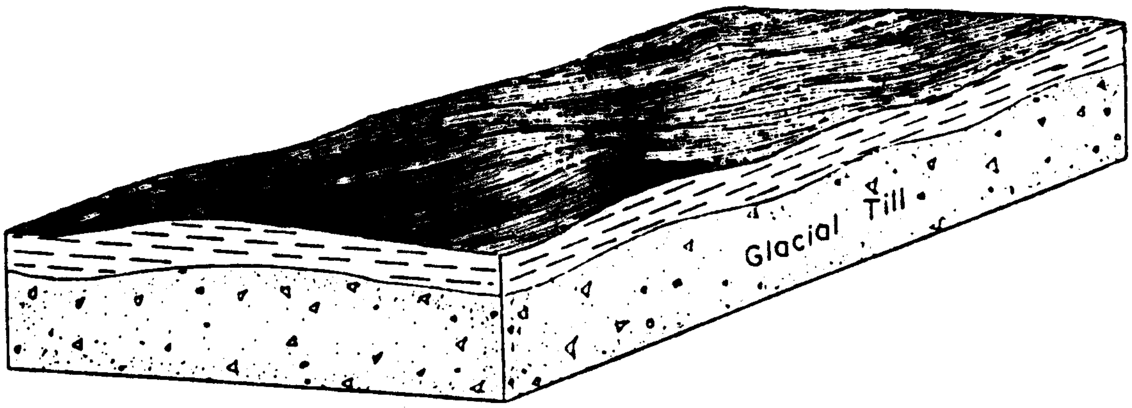

ROLLING SURFACE FORM




RIDGED SURFACE FORM

TERRACED SURFACE FORM




UNDULATING SURFACE FORM

11 Slope Gradient, %

| Code | Class |
|---|---|
| 01 | 0-3 |
| 04 | 4-9 |
| 10 | 10-15 |
| 16 | 16-29 |
| 30 | 30-59 |
| 60 | 60 + |
| ? | Unknown |
| # | Not Applicable |

12 Length of slope, m

| | |
|---|---|
| 001 | 1-49 |
| 050 | 50-149 |
| 150 | 150-299 |
| 300 | 300-599 |
| 600 | 600+ |
| ? | Unknown |
| # | Not Applicable |

13 Stoniness at Surface, m apart

| Code | Class(m) | Coverage(%) |
|---|---|---|
| 0.1 | 0 - 0.1 | 99 - 90 (Pavement) |
| 0.2 | 0.2 - 0.7 | 90 - 15 |

| | | |
|---|---|---|
| 0.8 | 0.8 - 1.5 | 15 - 3 |
| 1.6 | 1.6 - 9.0 | 3.0 - 0.1 |
| 10.0 | 10.0 - 30 | 0.1 - 0.01 |
| 30.0 | 30+ | <0.01 |
| ? | Unknown | |
| # | Not Applicable | |

14 Rockiness Outcrops - presence of hard rock(H) or softrock(S) outcrops, m apart.

| Code | Class | Exposure (%) |
|---|---|---|
| H01 | Hardrock outcrops 0 - 3m apart | 50 - 90 |
| H04 | Hardrock outcrops 4 - 9m apart | 25 - 50 |
| H10 | Hardrock outcrops 10 - 34m apart | 10 - 25 |
| H35 | Hardrock outcrops 35 - 98m apart | 2 - 10 |
| H99 | Hardrock outcrops 99 + m apart | <2 |
| S01 | Softrock outcrops 0 - 3 m apart: | 50 - 90 |
| ? | Unknown | |
| # | Not Applicable | |

15 Depth To Ground Water Table or Mottling, cm

| | |
|---|---|
| AL100 | Always less than 100 |
| TL100 | Temporarily less than 100 |
| AG100 | Always 100-200 |
| TG100 | Temporarily 100-200 |

| | |
|---|---|
| AG100 | Always greater than 100 |
| ML50 | Mottling less than 50 |
| MG50 | Mottling 50-99 |
| MG100 | Mottling greater than 100 |
| ? | Unknown |
| # | Not Applicable |

16 Quality of Ground Water, micro/mho/cm

| Code | Class |
|---|---|
| 0001 | 1 - 249 |
| 0250 | 250 - 749 |
| 0750 | 750 - 1499 |
| 1500 | 1500 - 2999 |
| 3000 | 3000+ |
| ? | Unknown |
| # | Not applicable |

17 Rooting, Depth which is unrestricted, cm

| Code | Class |
|---|---|
| 001 | 1 - 24 |
| 025 | 25 - 49 |
| 050 | 50 - 99 |
| 100 | 100 - 149 |
| 150 | 150 + |
| ? | Unknown |
| # | Not Applicable |

18 Predominant Land Use/Vegetation Type

| Code | Class |
|---|---|
| HO | Horticultural Land |
| OR | Orchard Land |
| AN | Annual Cropland |
| BO | Bog, Fen |
| SW | Swamp |
| PA | Pastureland, Cultivated |
| GR | Grassland, Native |
| PL | Plantation Land |
| BU | Bushland, Grazing |
| FO | Forestland, Natural |
| DS | Desertland |
| QU | Quaries, Mines, Pits |
| RO | Rockland or Rubbleland |
| RE | Outdoor Recreation, (Parks, Game Farms or Preserves) |
| SH | Shifting Cultivation in Forest Covered Land |
| UR | Urban |
| IC | Irrigated Annual Cropland |
| IO | Irrigated Orchard Land |
| IH | Irrigated Horticultural Land |
| SA | Salinity/Alkalinity Tolerant Plants |

| | |
|---|---|
| FU | Closed Forest, Unspecified (FAO, 1986) |
| FE | Closed Forest, Evergreen |
| FS | Closed Forest, Semi-deciduous |
| FD | Closed Forest, Deciduous |
| FX | Closed Forest, Xeromorphic |
| WU | Woodland, Unspecified (Open Stand of trees) |
| WE | Woodland, Evergreen |
| WS | Woodland, Semi-deciduous |
| WD | Woodland, Deciduous |
| WX | Woodland, Extremely Xerophytic |
| SU | Shrub, Unspecified |
| SE | Shrub, Evergreen |
| SS | Shrub, Semi-deciduous |
| SD | Shrub, Deciduous |
| SX | Shrub, Extremely Xerophytic |
| DU | Dwarf Shrub, Unspecified |
| DE | Dwarf Shrub, Evergreen |
| DS | Dwarf Shrub, Semi-deciduous |
| DD | Dwarf Shrub, Deciduous |
| DX | Dwarf Shrub, Extremely Xerophytic |
| DT | Dwarf Shrub, Tundra |

| | |
|---|---|
| HU | Herbaceous, Unspecified |
| HT | Herbaceous, Tall Grassland |
| HM | Herbaceous, Medium Grassland |
| HS | Herbaceous, Short Grassland |
| HF | Herbaceous, Forb |
| ? | Unknown |
| # | Not Applicable |

19 Surface Flooding Due To Inundation (I) or High Water Table (H), Months Land Surface Covered for

| Code | Class |
|---|---|
| IHO | No flooding |
| I01 | 0 - 1 month of flooding by inundation |
| I02 | 2 - 3 months of flooding by inundation |
| I04 | 4 - 6 months of flooding by inundation |
| I07 | 7 - 9 months of flooding by inundation |
| I10 | 10 - 12 months of flooding by inundation |
| H01 | 0 - 1 month of flooding by high water table |
| H02 | 2 - 3 months of flooding by high water table |
| H04 | 4 - 6 months of flooding by high water table |
| H07 | 7 - 9 months of flooding by high water table |
| H10 | 10 - 12 months of flooding by high water table |
| ? | Unknown |
| # | Not Applicable |

20 Propensity/Liability for Surface Crusting or Sealing or Surface Cracking

| Code | Class | Description |
|---|---|---|
| UNSL | Unslaked | |
| PART | Partly Slaked | - Round smooth aggregates |
| SLAK | Slaked | - Sorted sand/silt, some clay films |
| CAPP | Capped | - Crust on drying. |
| ? | Unknown | |
| # | Not Applicable | |

21 Surface Drainage or Run Off - rate of which water is drained from the terrain surface (Cochrane, ISIS)

| Code | Class |
|---|---|
| POND | Water ponds at the surface, and the soil is waterlogged for periods of a month or more. |
| SLOW | Water drains slowly, the soil does not remain waterlogged for a period greater than a month. |
| MEDI | Water drains at a medium rate, the soil is not waterlogged for more than 48 hours. |
| RAPI | Excess water drains rapidly, even during periods of prolonged heavy rainfall. |
| VERY | Excess water drains very rapidly, the soil cannot ensure adequate topsoil moisture for seed germination. |
| ? | Unknown |
| # | Not Applicable |

22 Overwash With Recent Water Erosion Products, % Occupance

| Code | Class |
| --- | --- |
| 01 | 0 - 2% |
| 03 | 3 - 9 |
| 10 | 10 - 39 |
| 40 | 40 - 74 |
| 75 | 75+ |
| ? | Unknown |
| # | Not Applicable |

23 Overblow With Recent Wind Erosion Products, % Occupance

| Code | Class |
| --- | --- |
| 01 | 0 - 2 |
| 03 | 3 - 9 |
| 10 | 10 - 39 |
| 40 | 40 - 74 |
| 75 | 75+ |

24 Water Erosion

| Code | Class |
| --- | --- |
| N | Non Eroded |
| S | Sheet Erosion |
| A | Rills < 10 cm deep, > 50 m apart |
| B | Rills < 10 cm deep, 20 - 50 m apart |

| | |
|---|---|
| C | Rills < 10 cm deep, < 20 m apart |
| | Gullies 25 - 100 cm deep, 20 - 50 m apart |
| D | Rills 10 - 25 cm deep, < 20 m apart |
| | Gullies 25 - 100 cm deep, < 20 m apart |
| | Gullies > 100 cm deep, 20-50 m apart |
| E | Land destroyed by gully erosion or ravines |
| ? | Unknown |
| # | Not Applicable |

25 Wind Erosion

| Code | Class |
|---|---|
| A | 0-1% area affected |
| B | 1-5% area affected |
| C | Part of A horizon removed; blow outs, 0-5 cm Deep on 10-40% of area |
| D | All A horizon removed; blow outs, 5-15 cm deep on 40-75% of area |
| E | Blowout > 15 cm deep on > 75% of area |
| R | Ripples occur on soil surface |
| ? | Unknown |
| # | Not Applicable |

26 Complexity of Parent Material and/or Soil

| Code | Class | |
|---|---|---|
| L | Low | - A maximum of 2 parent materials and/or soils occurring over relatively long distance. |

| | | |
|---|---|---|
| M | Medium | - 2 to 3 parent materials and/or soils occurring within relatively short distance |
| H | High | - At least 2 different materials on which are developed at least 2 different soils |
| ? | Unknown | |
| # | Not Applicable | |

27 Permafrost Distribution

| Code | Class | Description |
|---|---|---|
| S | Sporadic | - Only a very few isolated areas of organic soils are permanently frozen. |
| D | Discontinuous | - Occurs in some areas beneath the ground surface throughout a geographic regional landform where other areas are free of permafrost. |
| C | Continuous | - Occurs everywhere beneath the exposed land surface throughout a geographic regional landform with the exception of widely scattered sites such as newly deposited unconsolidated sediments. |
| ? | Unknown | |
| # | Not Applicable | |

28 Ice Content of Material

| Code | Class | Description |
|---|---|---|
| L | Low | - <60% by volume |
| M | Medium | - 60 - 80% by volume |
| H | High | - >80% by volume |
| ? | Unknown | |
| # | Not Applicable | |

## 11. SOTER SOIL LAYER FILE ATTRIBUTE LIST AND STRUCTURE

| No. | Attribute | Type | Width | Dec | Necessity Requirement in Layers* 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|
| 01 | Country Code | CHAR | 4 | | | | | |
| 02 | State or Province Code | CHAR | 2 | | | | | |
| 03 | Base Map Code | CHAR | 4 | | | | | |
| 04 | Report/Map Number Code | CHAR | 4 | | | | | |
| 05 | Polygon Number | CHAR | 4 | | | | | |
| 06 | Terrain Component Number in Which Soil Occurs | CHAR | 1 | | | | | |
| 07 | Slope Position | CHAR | 3 | | | | | |
| 08 | Internal Soil Drainage | CHAR | 4 | | | | | |
| 09 | Proportion of Polygon To Which Following Attributes Apply; Nearest 10%, or 5% Where Needed | NUM | 2 | | | | | |
| 10 | Previous Polygon Number with Same Soil Layer Data | CHAR | 4 | | | | | |
| 11 | Soil Number of Previous Polygon | CHAR | 1 | | | | | |
| 12 | Soil Number (1-3) | CHAR | 1 | | | | | |
| 13 | Layer or Soil Horizon Number(1-4) | CHAR | 1 | | | | | |

* Necessity Requirements of Data For The 4 Soil Layers Identified Are Referred To As: M-Mandatory; D-Desirable; O-Optional

| No. | Attribute | Type | Width | Dec | Necessity Requirement in Layers* | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 |
| 14 | Lower Depth of Layer or Soil Horizon, cm | CHAR | 3 | | | | | |
| 15 | Abruptness of Layer/Horizon Boundary to Underlying Layer | CHAR | 2 | | M | M | O | O |
| 16 | Soil Disturbance | CHAR | 2 | | M | M | O | O |
| 17 | Moist Munsell Color Hue, Nearest Chart | CHAR | 5 | | M | O | O | O |
| 18 | Moist Munsell Color Value, Nearest Unit | CHAR | 1 | | M | O | O | O |
| 19 | Moist Munsell Color Chroma, Nearest | CHAR | 1 | | M | O | O | O |
| 20 | Dry Munsell Hue, Nearest Chart | CHAR | 5 | | M | O | O | O |
| 21 | Dry Munsell Value, Nearest Unit | CHAR | 1 | | M | O | O | O |
| 22 | Dry Munsell Chroma, Nearest Unit | CHAR | 1 | | M | O | O | O |
| 23 | Organic Carbon, % | CHAR | 4 | 1 | M | D | O | O |
| 24 | Total Soil Nitrogen, % | CHAR | 4 | 2 | M | O | O | O |
| 25 | CEC, meq/100g Soil | CHAR | 2 | | M | M | M | O |
| 26 | CEC Clay, meq/100g Clay | CHAR | 4 | 1 | M | M | M | O |
| 27 | CEC Effective, meq/100 g Soil; at pH-Soil | CHAR | 4 | 1 | O | O | O | O |

| No. | Attribute | Type | Width | Dec | Necessity Requirement in Layers* 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|
| 28 | Anion Exchange Capacity me/100g soil; at pH-Soil | CHAR | 4 | 2 | O | O | O | O |
| 29 | Exchangeable CA | CHAR | 5 | 2 | M | M | M | O |
| 30 | Exchangeable MG | CHAR | 4 | 2 | M | M | M | O |
| 31 | Exchangeable NA | CHAR | 4 | 2 | M | M | M | O |
| 32 | Exchangeable K | CHAR | 4 | 2 | M | M | M | O |
| 33 | Exchangeable MN | CHAR | 4 | | D | D | D | D |
| 34 | Exchangeable AL | CHAR | 4 | 2 | M | M | M | O |
| 35 | Ca/Mg Ratio | CHAR | 2 | | D | D | D | D |
| 36 | Ca/K Ratio | CHAR | 2 | | D | D | D | D |
| 37 | Mg/K ratio | CHAR | 3 | 1 | D | D | D | D |
| 38 | Aluminum Saturation, % | CHAR | 2 | | M | M | M | M |
| 39 | Available P | CHAR | 1 | | M | M | O | O |
| 40 | P Fixation | CHAR | 4 | | D | D | D | D |
| 41 | Available S | CHAR | 4 | | D | D | D | D |
| 42 | Trace Element Deficiency | CHAR | 4 | | D | D | D | D |
| 43 | Toxicity/Potential Toxicity | CHAR | 4 | | D | D | D | D |
| 44 | Base Saturation, % | CHAR | 2 | | M | M | M | O |
| 45 | pH in Water(1:1), One Decimal | CHAR | 3 | 1 | M | M | M | M |
| 46 | pH in $CaCl_2$ or Kcl, One Decimal | CHAR | 3 | 1 | M | M | M | M |
| 47 | Electrical Conductivity, ds/m (mmhos/cm) | CHAR | 2 | | M | M | M | M |

| No. | Attribute | Type | Width | Dec | Necessity Requirement in Layers* 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|
| 48 | ESP | CHAR | 2 | | M | M | M | M |
| 49 | Total $CaCO_3$ Equivalent, %; Primary, Secondary incl. Nodules | CHAR | 3 | | O | O | O | O |
| 50 | Gypsum (CaS04.2H20) | CHAR | 2 | | M | M | M | M |
| 51 | Clay Mineralogy | CHAR | 4 | | O | O | O | O |
| 52 | Coarse Fragments,% | CHAR | 2 | | M | M | O | O |
| 53 | Texture, Class, (USDA) | CHAR | 4 | | M | M | M | M |
| 54 | Sand, Total, % | CHAR | 2 | | O | O | O | O |
| 55 | Very Fine Sand,% | CHAR | 2 | | O | O | O | O |
| 56 | Silt, Total,% | CHAR | 2 | | O | O | O | O |
| 57 | Clay, Total,% | CHAR | 2 | | O | O | O | O |
| 58 | Available Water Capacity, Upper Limit (i.e. field capacity) Definition kPA | CHAR | 2 | | M | M | M | M |
| 59 | Available Water Capacity, Lower Limit (i.e. wilting point) Definition KPa | CHAR | 4 | | M | M | M | M |
| 60 | Available Water Capacity, Upper Limit Volume % | CHAR | 2 | | M | M | M | M |
| 61 | Available Water Capacity, Lower Limit Volume % | CHAR | 2 | | M | M | M | M |
| 62 | Bulk Density, $kg/m^3$ ($g/cm^3$) | CHAR | 4 | 2 | M | M | M | M |
| 63 | Infiltration/Percolation, cm/H | CHAR | 4 | | M | O | O | O |
| 64 | Saturated Hydraulic Conductivity, cm/H | CHAR | 4 | | O | O | O | O |

| No. | Attribute | Type | Width | Dec | Necessity Requirement in Layers* | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 |
| 65 | Structure | CHAR | 2 | | M | M | M | M |
| 66 | Stable Soil Aggregates | CHAR | 2 | | D | D | D | D |
| 67 | Decomposition Degree | CHAR | 3 | | M | M | M | M |
| 68 | Biological Activity | CHAR | 3 | | D | D | D | D |
| 69 | Contrasting Layer | CHAR | 1 | | M | M | M | M |
| 70 | Diagnostic Horizon/Features | CHAR | 4 | | M | M | M | O |
| 71 | Diagnostic Horizon;Defined Source | CHAR | 3 | | M | M | M | M |
| 72 | Soil Development | CHAR | 4 | | M | | | |
| 73 | Reference Pedon | CHAR | 6 | | M | M | M | M |

NOTE: Underlined Characters of attribute name key words are used to label attributes (or fields of information) on coding forms.

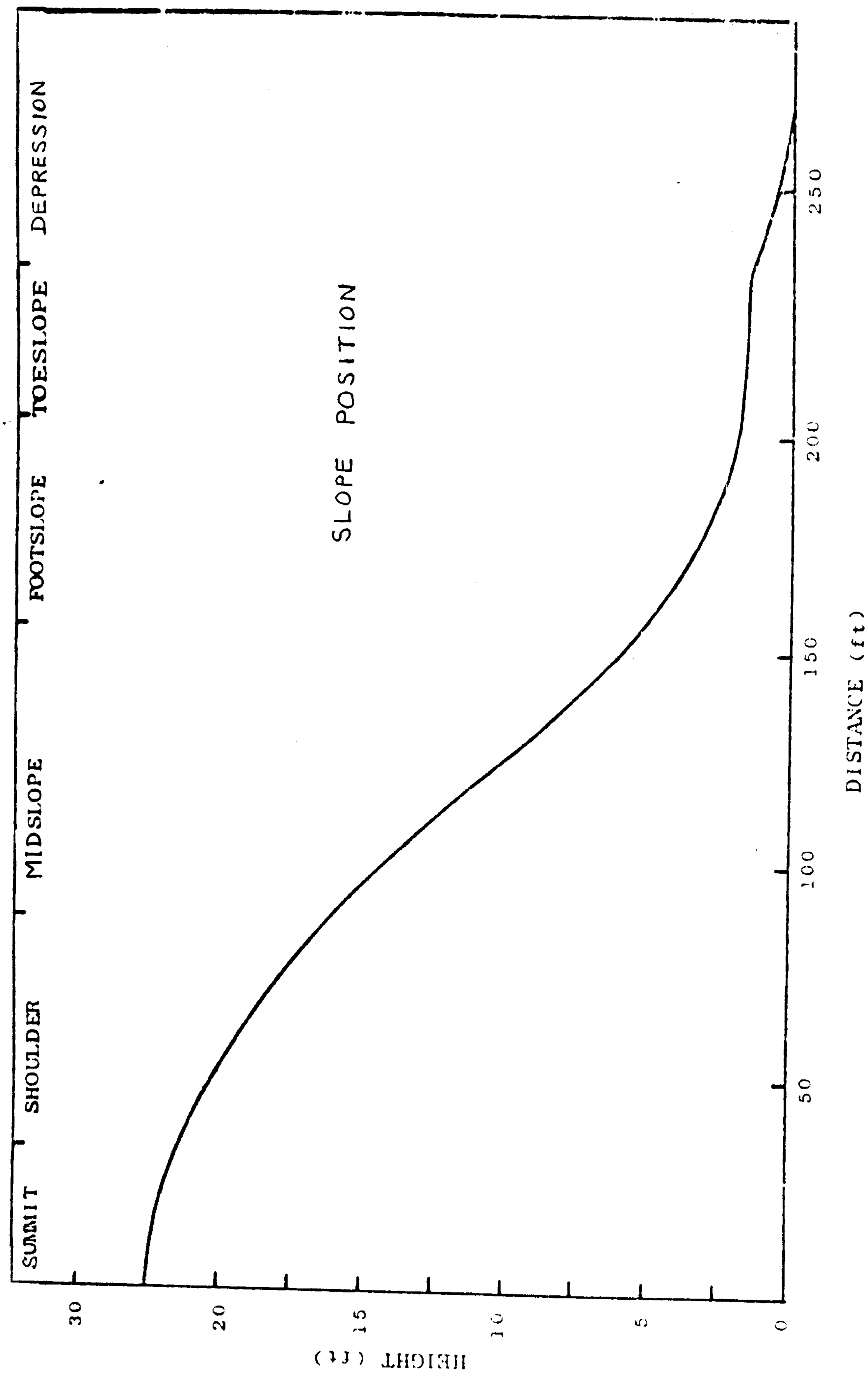
# 12. SOTER SOIL LAYER ATTRIBUTE CLASSES, CODES AND DESCRIPTIONS

| | | | |
|---|---|---|---|
| 01 | Country Code | - | 4 Number International Code (ISIS) |
| 02 | State or Province Code | - | 2 Number National Code |
| 03 | Base Map Code | - | 4 Character National Code |
| 04 | Report/Map Ref. Code | - | 4 Number State or Province Code |
| 05 | Polygon Number | - | 4 Number, Unique for each map Polygon |
| 06 | Terrain Component Number In Which the Described Soil Occurs (1-3) | | |
| 07 | Slope Position | - | position on local slope where described soil occurs (see diagram) |

| Code | Class | Description |
|---|---|---|
| SUM | Summit | See Diagram on next page |
| SHO | Shoulder | See Diagram on next page |
| MID | Midslope | See Diagram on next page |
| FOO | Footslope | See Diagram on next page |
| TOE | Toeslope | See Diagram on next page |
| DEP | Depression | See Diagram on next page |
| ALL | All Positions | See Diagram on next page |
| ? | Unknown | |
| # | Not Applicable | |

08 Internal Soil Drainage

| Code | Class | Description |
|---|---|---|
| EXCE | Excessive | - Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very |


SUMMIT
SHOULDER
MIDSLOPE
FOOTSLOPE
TOESLOPE
DEPRESSION
SLOPE POSITION
HEIGHT (ft)
30
20
15
10
5
0
DISTANCE (ft)
50
100
150
200
250

| | | |
|---|---|---|
| | | rapidly if underlying material is pervious. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Water source is precipitation. |
| RAPI | Rapid | - Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Water source is precipitation. |
| WELL | Well | - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. These soils commonly retain optimum amounts of moisture for plant growth after rains or addition of irrigation water. |

| | | | |
|---|---|---|---|
| IMPE | Imperfect | - | Water is removed from the soil sufficiently slowly in relation, to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is the major supply. If subsurface water or groundwater, or both, is the main source, the flow rate may vary but the soil remains wet for a significant part of the growing season. |
| POOR | Poor | - | Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface flow or groundwater flow, or both, in addition to precipitation are the main water sources; there may also be a perched water table. |

| | | |
|---|---|---|
| VPOO | Very Poor | - Water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen. Groundwater flow and subsurface flow are the major water sources. Precipitation is less important except where there is a perched water table. |
| ? | Unknown | |
| # | Not Applicable | |

09 Proportion of Polygon to which the following attributes apply, nearest 10%; where needed 5%, Right Justified

? Unknown

# Not applicable

10 Previous Polygon Number with Same Soil Data - refers to the polygon number in which the same soil occurs and has already been coded. Therefore, it is not necessary to code the same data again; it will be done by the computer.

#Not Applicable should be coded if the same soil data has not been recorded previously.

11 Soil Number of Above Polygon (See 10) with Same Soil Data - refers to the soil number of the above Polygon in which the same soil occurs so it is not necessary to code the data again.
#Not Applicable should be coded if the same soil data has not been recorded previously.

12 Soil Number, Listed According to the Largest Proportion of Polygon to Which it Applies

13 Layer or Soil Horizon Number, 1-4

14 Lower Depth of Layer or Soil Horizon, cm, Right Justified (Top of surface layer is 0 cm)
NOTE: Each soil may have a maximum of 4 layers in a continuum to a depth of 150 cm: - 2 Layers to about 50 cm
- 2 Layers from about 50 cm up to 150 cm.

15 Abruptness of Horizon/Layer Boundary to Underlying Horizon

| Code | Class |
|---|---|
| AB | Abrupt |
| GR | Gradual |
| DI | Diffuse |
| ? | Unknown |
| # | Not Applicable |

16 Soil Disturbance (i.e. disturbed or natural)

| Code | Class |
|---|---|
| DI | Disturbed |
| UN | Undisturbed |
| ? | Unknown |
| # | Not Applicable |

17 Moist Munsell Color Hue, Nearest Chart, Left Justify

| | |
|---|---|
| ? | Unknown |
| # | Not applicable |

18 Moist Munsell Color Value, Nearest Unit

| | |
|---|---|
| ? | Unknown |
| # | Not applicable |

19 Moist Munsell Color Chroma, Nearest Unit

| | |
|---|---|
| ? | Unknown |
| # | Not applicable |

20 Dry Munsell Hue, Nearest Chart, Left Justify

| | |
|---|---|
| ? | Unknown |
| # | Not Applicable |

21 Dry Munsell Value, Nearest Unit

| | |
|---|---|
| ? | Unknown |
| # | Not Applicable |

22 Dry Munsell Chroma, Nearest Unit

| | |
|---|---|
| ? | Unknown |
| # | Not applicable |

23 Organic Carbon, %

| Code | Class |
|---|---|
| 00.1 | 0 - 0.2 |
| 00.3 | 0.3 - 0.6 |
| 00.7 | 0.7 - 1.9 |
| 02.0 | 2.0 - 2.9 |
| 03.0 | 3.0 - 7.9 |
| 08.0 | 8.0 - 16.9 |
| 17.0 | 17.0+ |
| ? | Unknown |
| # | Not applicable |

24 Total Soil Nitrogen - % of soil by weight

| Code | Class |
|---|---|
| 0.01 | 0.01 - 0.09 |
| 0.10 | 0.10 - 0.19 |
| 0.20 | 0.20 - 0.49 |
| 0.50 | 0.50 - 0.99 |
| 1.00 | 1.00+ |
| ? | Unknown |
| # | Not Applicable |

25 CEC, meq/100g soil

| Code | Class |
|---|---|
| 01 | 0 - 2 |
| 03 | 3 - 5 |
| 06 | 6 - 12 |

| | | |
|---|---|---|
| | 13 | 13 - 29 |
| | 30 | 30 - 35 |
| | 36 | 36+ |
| | ? | Unknown |
| | # | Not applicable |

26 CEC Clay, meq/100g Clay; pH 7.0

| Code | Class |
|---|---|
| 00.1 | 0 - 1.4 |
| 01.5 | 1.5 - 5.9 |
| 06.0 | 6.0 - 16 |
| 17.0 | 17 - 23 |
| 24.0 | 24 - 36 |
| 37.0 | 37+ |
| ? | Unknown |
| # | Not applicable |

27 CEC Effective meq/100g Clay; pH of Acid Soil

| Code | Class |
|---|---|
| 0.1 | 0.0 - 1.4 |
| 1.5 | 1.5 - 1.9 |
| 2.0 | 2.0 - 4.9 |
| 5.0 | 5.0 - 9.9 |
| 10 | 10+ |
| ? | Unknown |
| # | Not applicable |

28 Anion Exchange Capacity, meq/100 Soil and pH Soil

| Code | Class |
|---|---|
| 0.10 | 0 - 0.24 |
| 0.25 | 0.25 - 0.49 |
| 0.50 | 0.50 - 0.99 |
| 1.00 | 1.00+ |
| ? | Unknown |
| # | Not applicable |

29 Exchangeable Ca, meq/100 g Soil

| Code | Class |
|---|---|
| 0.01 | 0 - 0.03 |
| 0.04 | 0.04 - 0.99 |
| 1.00 | 1.00 - 2.99 |
| 3.00 | 3.00 - 5.99 |
| 6.00 | 6.00 - 11.00 |
| 12.00 | 19.00 |
| 20.00 | 20.00+ |
| ? | Unknown |
| # | Not Applicable |

30 Exchangeable Mg, meq/100g Soil

| Code | Class |
|---|---|
| 0.01 | 0 - 0.02 |
| 0.03 | 0.03 - 0.06 |
| 0.07 | 0.07 - 0.10 |
| 0.11 | 0.11 - 3.0 |
| 3.10 | >3.0 |
| ? | Unknown |
| # | Not applicable |

31 Exchangeable Na, meq/100g Soil

| Code | Class |
| --- | --- |
| 0.01 | 0 - 0.04 |
| 0.05 | 0.05 - 0.09 |
| 0.10 | 0.1 - 0.9 |
| 1.00 | 1.0 - 4.9 |
| 5.00 | 5.0+ |
| ? | Unknown |
| # | Not Applicable |

32 Exchangeable K, meq/100g Soil

| Code | Class |
| --- | --- |
| 0.01 | 0 - 0.05 |
| 0.06 | 0.06 - 0.19 |
| 0.20 | 0.20 - 0.29 |
| 0.30 | 0.30 - 7.99 |
| 8.00 | 8.00+ |
| ? | Unknown |
| # | Not applicable |

33 Exchangeable Mn, meg/100g Soil

| Code | Class |
| --- | --- |
| 0.01 | 0 - 0.05 |
| 0.06 | 0.06 - 0.10 |
| 0.11 | 0.11 - 1.00 |
| 1.10 | 1.10 - 2.00 |
| 2.00 | 2.0+ |

34 Exchangeable Al, meq/100g Soil

| Code | Class |
|---|---|
| 0.1 | 0 - 0.5 |
| 0.6 | 0.6 - 1.5 |
| 1.6 | 1.6 - 2.5 |
| 2.6 | 2.6+ |
| ? | Unknown |
| # | Not applicable |

35 Ca/Mg Ratio

| Code | Class |
|---|---|
| 01 | 0 - 1.9 |
| 02 | 2+ |
| ? | Unknown |
| # | Not applicable |

36 Ca/K Ratio

| Code | Class |
|---|---|
| 01 | 0 - 4.9 |
| 05 | 5+ |
| ? | Unknown |
| # | Not applicable |

37 Mg/K

| Code | Class |
|---|---|
| 0.1 | 0 - 0.4 |
| 0.5 | 0.5+ |

| | |
|---|---|
| ? | Unknown |
| # | Not applicable |

38 Al Saturation, %

| Code | Class |
|---|---|
| 01 | 0 - 9 |
| 10 | 10 - 49 |
| 50 | 50 - 74 |
| 75 | 75+ |
| ? | Unknown |
| # | Not applicable |

39 Available P, ppm

| CODE | Bray II | Truog | Olsen |
|---|---|---|---|
| A | <3 | <2 | <1 |
| B | 3-5 | 2-4 | 1-2 |
| C | 5-7 | 4-5 | 2-3 |
| D | 7-12 | 5-15 | 3-6 |
| E | >12 | >15 | >6 |
| ? | Unknown | | |
| # | Not applicable | | |

40 P Fixation

| Code | Class |
|---|---|
| PRES | Present |
| ABSE | Absent |
| POSS | Possible |
| UNLI | Unlikely |

41 Available S

| Code | Class |
|---|---|
| DEFI | Deficient |
| SATI | Satisfactory |
| ? | Unknown |
| # | Not applicable |

42 Trace Element Deficiency

| Code | Class |
|---|---|
| PROB | Probable |
| POSS | Possible |
| UNLI | Unlikely |
| ? | Unknown |
| # | Not applicable |

43 Toxicity/Potential Toxicity

| Code | Class |
|---|---|
| PROB | Probable |
| POSS | Possible |
| UNLI | Unlikely |
| ? | Unknown |
| # | Not applicable |

44 Base Saturation, % (relative to CEC, pH 7)

| Code | Class |
|---|---|
| 01 | 0-09 |
| 10 | 10-24 |
| 25 | 25-49 |

| | |
|---|---|
| 50 | 50-74 |
| 75 | 75-100+ |
| ? | Unknown |
| # | Not applicable |

45 pH in Water

| Code | Class |
|---|---|
| 0.1 | 0.1 - 3.8 |
| 3.9 | 3.9 - 5.4 |
| 5.5 | 5.5 - 6.5 |
| 6.6 | 6.6 - 8.3 |
| 8.4 | 8.4 - 9.0 |
| 9.1 | 9.1+ |
| ? | Unknown |
| # | Not applicable |

46 pH in $CaCl_2$/Kcl

| Code | Class |
|---|---|
| 0.1 | 0.1 - 3.5 |
| 3.6 | 3.6 - 5.0 |
| 5.1 | 5.1 - 6.5 |
| 6.6 | 6.6 - 8.4 |
| 8.5 | 8.5 - 9.0 |
| 9.1 | 9.1+ |
| ? | Unknown |
| # | Not applicable |

47 Electrical Conductivity, dS/m (mmhos/cm, saturation extract)

| Code | Class |
| --- | --- |
| 01 | 0 - 4 |
| 05 | 5 - 8 |
| 09 | 9 - 15 |
| 16 | 16 - 25 |
| 26 | 26 - 49 |
| 50 | 50+ |
| ? | Unknown |
| # | Not applicable |

48 ESP, %

| Code | Class |
| --- | --- |
| 01 | 0 - 8 |
| 09 | 09 - 15 (limit for natric horizon) |
| 16 | 16 - 25 |
| 26 | 26 - 39 |
| 40 | 40+ |
| ? | Unknown |
| # | Not applicable |

49 Total $CaCO_3$ Equivalent, % (P-Primary; S-Secondary)

| Code | Class |
| --- | --- |
| P00 | P 0 |
| P01 | P 1 - 5 |
| P06 | P 6 - 14 |

| | |
|---|---|
| P15 | P 15 - 39 |
| P40 | P 40+ |
| S00 | S 0 |
| S01 | S 1 - 5 |
| S06 | S 6 - 14 |
| S15 | S 15 - 39 |
| S40 | S 40+ |
| ? | Unknown |
| # | Not applicable |

50 Gypsum, $CaSO_4.2H2O$, %

| Code | Class |
|---|---|
| 01 | 0 - 2 |
| 03 | 3 - 5 (Limit of Gypsic Horizon) |
| 06 | 6 - 09 |
| 10 | 10 - 24 |
| 25 | 25 - 39 |
| 40 | 40+ |
| ? | Unknown |
| # | Not applicable |

51 CLAY Mineralogy

| Code | Class |
|---|---|
| KAOL | Kaolinitic |
| MONT | Montmorillonitic |

| | |
|---|---|
| ILLI | Illitic |
| VERM | Vermiculitic |
| CHLO | Chloritic |
| MIXE | Mixed |
| ALLO | Allophane |
| CARB | Carbonitic |
| OXID | Oxidic ($Fe_2O_3$) |
| GYPS | Gypsic |
| ? | Unknown |
| # | Not applicable |

52 Coarse Fragments, % volume

| Code | Class |
|---|---|
| 01 | 0 - 2 |
| 03 | 3 - 14 |
| 15 | 15 - 39 |
| 40 | 40 - 79 |
| 80 | 80+ |
| ? | Unknown |
| # | Not applicable |

53 Texture, Classes (USDA) as defined in CanSIS Manual

| Code | Class |
|---|---|
| S | Sand |
| GLS | Gravelly loamy sand |
| LS | Loamy sand |
| LFS | Loamy fine sand |
| FS | Fine sand |
| VS | Very fine sand |

| | |
|---|---|
| LVFS | Loamy very fine sand |
| GS | Gravelly sand |
| VGS | Very Gravelly sand |
| CB | Cobbly |
| CBSL | Cobbly sandy loam |
| SL | Sandy loam |
| FSL | Fine sandy loam |
| GFSL | Gravelly fine sandy loam |
| GSL | Gravelly sandy loam |
| VGSL | Very gravelly sandy loam |
| GL | Gravelly loam |
| CBGL | Cobbly gravelly loam |
| CBL | Cobbly loam |
| L | Loam |
| GSIL | Gravelly silt loam |
| VFSL | Very fine sandy loam |
| SIL | Silt loam |
| GCL | Gravelly clay loam |
| SCL | Sandy clay loam |
| VCL | Very fine sandy clay loam |
| CL | Clay loam |
| SICL | Silty clay loam |
| SC | Sandy clay |
| GSIC | Gravelly silty clay |
| C | Clay |
| HC | Heavy clay |
| ? | Unknown |
| # | Not applicable |

54 Sand, Total %

? Unknown

# Not Applicable

55 Very Fine Sand, %

? Unknown

# Not applicable

56 Silt, Total, %

? Unknown

# Not Applicable

57 Clay, Total, %

? Unknown

# Not Applicable

58 Available Water Capacity, Upper Limit, KPa
(i.e. field capacity) Definition KPa

? Unknown

# Not applicable

59 Available Water Capacity, Lower Limit, KPa
(i.e. wilting point) Definition KPa

? Unknown

# Not applicable

60 Available Water Capacity, Upper Limit, Volume%

? Unknown

# Not applicable

61 Available Water Capacity, Lower Limit, Volume%

| | |
|---|---|
| ? | Unknown |
| # | Not applicable |

62 Bulk Density, kg/m$^3$ (g/cm$^3$)

| Code | Class |
|---|---|
| 0.10 | 0.1 - 0.7 |
| 0.80 | 0.8 - 0.95 |
| 0.96 | 0.96 - 1.19 |
| 1.20 | 1.20 - 1.49 |
| 1.50 | 1.50 - 1.79 |
| 1.80 | 1.80+ |
| ? | Unknown |
| # | Not applicable |

63 Infiltration/Percolation, cm/hr

| Code | Class |
|---|---|
| 0.1 | 0 - 0.5 |
| 0.6 | 0.6 - 14 |
| 15 | 15+ |
| ? | Unknown |
| # | Not applicable |

64 Saturated Hydraulic Conductivity, cm/hr

| Code | Class |
|---|---|
| 0.1 | 0 - 0.5 |
| 0.6 | 0.6 - 14 |
| 15 | 15+ |
| ? | Unknown |
| # | Not applicable |

65 Structure

| Code | Class |
|---|---|
| 01 | Single grain; weak fine subangular blocky; weakly coherent porous massive. |
| 02 | Moderate fine to medium subangular blocky; weak fine to medium, angular blocky; weak to moderate crumb; moderate to strongly coherent porous massive; |
| 03 | Moderate, coarse subangular blocky; moderate fine to medium angular blocky; strong crumb; weak fine to medium prismatic; moderate coarse platy. |
| 04 | Strong, coarse, subangular blocky; strong fine to medium, angular (+ nutty/polyhedric) blocky; moderate coarse angular blocky; moderate fine to medium prismatic; weak coarse prismatic; non-porous massive |
| 05 | Strong coarse angular blocky; moderate to strong coarse prismatic; columnar; moderate to strong platy. |
| ? | Unknown |
| # | Not applicable |

66 Stable Soil Aggregates Retained by US Standard Seive Number 20 (0.8 mm grain size), %;

| | |
|---|---|
| ? | Unknown |
| # | Not Applicable |

67 Decompostion Degree

| Code | Class |
|---|---|
| FIB | Fibric |
| MES | Mesic (hemic) |
| HUM | Humic (sapric) |
| ? | Unknown |
| # | Not applicable |

68 Biological Activity

| Code | Class | Description |
|---|---|---|
| NON | None | - None |
| FEW | Few | - Few observable roots and/or biopores |
| COM | Common | - Readily observable roots and/or biopores |
| MAN | Many | - Many readily observable roots and/or biopores |
| ? | Unknown | |
| # | Not Applicable | |

69 Contrasting Layers to the Overlying Layer

| Code | Class |
|---|---|
| A | Clay |
| B | Clay loam to loam |
| C | Sand |
| D | Gravel cemented by gibsite |
| E | Compacted man made |
| F | Compacted basal morainal |
| G | Consolidated acid rock |
| H | Consolidate basic rock |

| | |
|---|---|
| I | Saturated |
| J | Indurated |
| P | Plinthite |
| K | Thin Cemented |
| L | Cemented by organic matter, Fe, Al |
| M | Fragipan |
| N | Clay pan |
| X | Not present |
| ? | Unknown |
| # | Not applicable |

70 Diagnostic Horizon/Features

| Code | Class |
|---|---|
| MOLL | Mollic A |
| FIMI | Fimic A |
| HIST | Histic A |
| UMBR | Umbric A |
| OCHR | Ochric A |
| ARGI | Argillic B |
| NATR | Natric B |
| CAMB | Cambic B |
| SPOD | Spodic B (Podzolic B) |
| OXIC | Oxic B |
| CALC | Calcic |
| GYPS | Gypsic |
| SULP | Sulphuric |
| ALBI | Albic E |
| CRYI | Frozen Permanently (Cryic) |

| | |
|---|---|
| GLEY | Strongly gleyed or reduced |
| VERM | Vermic |
| VERT | Vertic |
| ANDI | Andic |
| ? | Unknown |
| # | Not applicable |

71 Diagnostic Horizon Defined in:

| Code | Class |
|---|---|
| TAX | Soil Taxonomy Classification System |
| FAO | FAO System |
| NAT | National System of Project Area |
| ? | Unknown |
| # | Not applicable |

72 Soil Development (International Reference Base Group of ISSS Commission V, Jan/87, Rome)

| Code | Class | | Description |
|---|---|---|---|
| | HISTIC | - | Strong accumulation of organic materials associated with low temperatures and/or waterlogging. |
| | VERTIC | - | Churning of soil material as a result of swelling and shrinking. |

| | | |
|---|---|---|
| ANDIC | - | Weathering of volcanic material resulting in the formation of amorphous alumino-silicates |
| PODZIC | - | Illuvial accumulation of amorphous compounds of organic matter, iron and aluminum |
| FERRALIC | - | Residual accumulation of sesquioxides as a result of strong weathering |
| STAGNIC | - | Surface waterlogging |
| NITIC | - | Illuvial accumulation of clay |
| LUVIC | - | Illuvial accumulation of high activity clays |
| LIXIC | - | Illuvial accumulation of low activity clays |
| GLEYIC | - | Reduction as a result of groundwater influence |
| HALIC | - | Accumulation of soluble salts |
| CHERNIC | - | Surface accumulation of saturated organic matter |
| CALCIC | - | Accumulation of calcium carbonate and/or gypsum |
| CAMBRIC | - | Weathering in situ leading to a change in colour, texture or consistence without important translocations |

| | | |
|---|---|---|
| MODER | - | Surface accumulation of desaturated organic matter |
| ANTHRIC | - | Pronounced human influence |
| PRIMIC | - | Absence of distinct attributes due to soil formation |

73 Reference Pedon Number - National Soil Name Data file

## 13. CODING FORMS

Coding (or recording) data in attribute files is an integral part of SOTER Map and attribute compilation procedures. Data is usually coded on specially designed hard copy coding forms and then input to similar computer data file structure created according to dBASE or INFO commercial software packages. Alternatively, data can be input directly to the computer data base files. However, data compilation usually requires considerable time to aquire information from legends, reports and other sources which necessitates having a personal computer dedicated especially to the project. Consequently, it is considered more practical to initially record data on hard copy. Coding Forms were never dicussed in detail by the Legend Working Group. However, some ideas were put foreward which have been reviewed and revised for trial.

Two coding forms are proposed for this project, one on which to record polygon and terrain component attributes (SOTER Coding Form 1, See attached) and one on which to record soil attributes (SOTER Coding Form 2, See attached). Polygon and terrain component attribute files are conveniently combined on Form 1. There is some repetitious coding involved when more than one terrain component occurs per polygon. However, if two separate forms were used, the first four fields would also have to be repeated on each form.

Coding Forms 1 and 2 are intended as examples to provide insight as to what format is considered convenient and what is involved in the coding exercise.

Obviously, there are many ways the legend files and coding forms can be organized. For example, the soil attribute file could be reorganized into 3 or 4 smaller files (morphological, chemical, physical) as suggested by P. Brabant (personal communication). Alternately, the attributes required by priority interpretation could be organized into a smaller special file. In fact, attribute organization into a number of smaller files is recommended as a general principle of most data base management systems including INFO. However, experience has shown that using multiple files requires the client to be very knowledgeable with the software commands and must be able to do some programming.

To retrieve (or select) attributes from two or more different files (morphology, chemical, physical) one has to temporarily relate or combine these files on each occasion, or program a join. If it is necessary to join, it may be more convenient to have one large file depending on the software package. Large files of 100 fields are no problem for dBASE, but have undesirable implications for INFO which cannot readily "pan" across files that exceed 80 columns in width. We are still exploring the capabilities of INFO and will have more to report in March/88.

<u>Coding Form Format</u>

Each form is created according to the structure (attribute field width) documented in the respective attribute file.

Attributes are entered from left to right in the same order as listed in their respective files (see Polygons, Terrain Component and Soil File Attribute Lists). In the case of Coding Form 1, the Polygon Attributes are listed first, followed by Terrain Component Attributes commencing at attribute 06 (Proportion of Polygon to which the following attributes apply). The fields are also numbered according to the numbering sequence provided in the respective attribute listings. Colums are provided for decimals.

Attribute names are abbreviated to a field name (or label) with a maximum of 4 characters, usually the first 4 characters of the Attribute Name Key Word (See underlined characters in File Attribute Lists). The field name (or 4 character string) is unique among files. Since many of the fields on the coding forms are less than 4 colums wide, it is necessary that the labels (or names)are orientated vertically within the field. This vertical label of 4 characters can also be conveniently retrieved by the dBase Report Generator. These abbreviated attribtute field names become easier to remember connotatively as one becomes more familiar with the coding form. The short label also saves many key strokes when copying selected fields or generating reports with selected fields of information.

The attached coding forms are prepared on standard 80 column data coding paper. Since both files exceeded 80 columns, the attribute fields were documented on a series of coding paper sheets which could then be joined end to end as required. This format, although physically wide, provided a better option than coding this data on 2 to 3 separate pages which only increases the number of pages of coded data to organize and keep track of.

During the planning stage, it is not a major problem to either rearrange the order of attributes within a file or to reorganize a file into smaller files. However, the file structures and coding forms must be finalized before data is compiled and input to the computer.

To expedite the coding procedure, each file attribute list (Polygon, Terrain, Soil) and their respective class codes were summarized as briefly as possible to one or two pages (see attached). These summaries provide the map and data compiler with rapid access to the appropriate attribute class codes for data derived from map legends and reports. To use the summary file efficiently, it is essential that the compiler be very familiar with the more detailed description of the attribute classes documented previously in the Manual.

Immediately following the coding procedure, data were input to dBase III installed on a personal computer; a report was then generated (see attached). As indicated previously, the dBase Report Generator can accommodate field labels of up to 4 lines (or 4 vertical characters). Thereby, a Report of the data coded can be quickly printed out in the same format as it occurred on the coding form (see attached). This provides for convenient editing. Corrections or revisions can then be made interactively at the terminal.

Reports of attribute subsets from any file with a complete field title can also be generated and outputted to print. Alternatively, files can be combined (or related, or joined etc.) and attributes from any of the 3 files can be selected for a Report.

SUMMARY POLYGON FILE ATTRIBUTE LISTS AND CLASS CODES

01 COUNTRY CODE:
02 STATE/PROVINCE CODE:
03 BASE MAP CODE:
04 REPORT/MAP NUMBER CODE:
05 POLYGON NUMBER
06 REGIONAL LANDFORM:
- M MOUNTAIN
- H HILLAND
- T TABLELAND (OR PLATEAU)
- P PLAIN
- V VALLEY
- U UPLAND (FOOTHILL)
- F FOOTSLOPE

07 RELIEF, MEDIAN, M:
08 ELEVATION, MEDIAN, M:
09 LITHOLOGY:

| | | | |
|---|---|---|---|
| IGNE | IGENEOUS ROCK | MARI | MARINE DEPOSIT |
| META | METAMORPHIC ROCK | ALLU | ALLUVIAL DEPOSIT |
| SEDI | SEDIMENTARY ROCK | EOLI | EOLIAN DEPOSIT |
| SAND | SANDSTONE ROCK | GLAC | GLACIAL DRIFT DEPOSIT |
| SHAL | SHALE ROCK | COLL | COLLUVIAL DEPOSIT |
| PYRO | PYROCLASTIC ROCK | RESI | RESIDUAL DEPOSIT |
| MIXE | MIXED ROCK | UNDI | UNDIFFERENTIATED DEPOSIT |
| WEAT | WEATHERED ROCK | ORGA | ORGANIC DEPOSIT |
| UNSP | UNSPECIFIED ROCK | ICE | ICE |

10 PERMANENT LAKE SURFACE, %:
11 SEASONALLY INUNDATED LANDS, %
12 MEDIAN DISTANCE BETWEEN RIVERS, OR STREAM, KM:
13 DENSITY OF RIVER AND STREAM DRAINAGE
14 PREDOMINANT GENERAL LAND USE

| | | | |
|---|---|---|---|
| ANNU | ANNUAL CROPLAND | DESE | DESERTLAND |
| PAST | CULTIVATED PASTURELAND | ORGA | ORGANIC SWAMP, BOG OR FEN |
| GRAS | GRASSLAND, NATIVE | TUND | TUNDRA |
| SHIF | SHIFTING CULTIVATION ON FOREST COVERED LAND | IRRI | IRRIGATED LAND |
| FORE | FORESTLAND (CLOSED STAND) | WOOD | WOODLAND (OPEN STAND) |
| PLAN | PLANTATION LAND | SHRU | SHRUBLAND |
| ORCH | ORCHARD LAND | DWAR | DWARFSHRUBLAND |
| ROCK | ROCKLAND OR RUBBLELAND | | |

SUMMARY TERRAIN COMPONENT ATTRIBUTE LIST AND CLASS CODES

01 COUNTRY CODE:
02 STATE/PROVINCE CODE:
03 BASE MAP CODE:
04 REPORT/MAP NUMBER CODE:
05 POLYGON NUMBER:
06 PROPORTION OF POLYGON:
07 TERRAIN COMPONENT (1-3):
08 PARENT MATERIAL/ROCK:

| | | | | | |
|---|---|---|---|---|---|
| AL | ALLUVIAL | MA | MARL | SH | SHALE ROCK |
| CO | COLLUVIAL | RE | RESIDIUUM | LI | LIMESTONE ROCK |
| EO | EOLIAN | OB | ORGANIC BOG | SA | SCHIST ROCK, ACID |
| FL | FLUVIOGLACIAL | OF | ORGANIC FEN | SB | SCHIST ROCK, BASIC |
| LA | LACUSTRINE | OS | ORGANIC SWAMP | GA | GNEISS ROCK ACID |
| MO | MORAINAL | OU | ORGANIC UNDIFFERENTIATED | GB | GNEISS ROCK BASIC |
| AN | ANTHROPOGENIC | CA | CRYSTALLINE ROCK, ACID | EA | EFFUSIVE ROCK, ACID |
| UN | UNDIFFERENTIATED | CB | CRYSTALLINE ROCK, BASIC | EB | EFFUSIVE ROCK BASIC |
| MA | MARINE | SN | SANDSTONE ROCK | RU | ROCK UNSPECIFIED |
| | | | | IC | ICE |
| | | | | WA | WATER |

09 TEXTURE GROUP OF PARENT MATERIAL:
- X EXTREMELY SANDY
- S SANDY
- L LOAMY
- C CLAYEY
- Y VERY CLAYEY

10 SURFACE FORM:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| G | GULLIED | S | STEEP | B | BLANKET BOG | K | HORIZONTAL FEN |
| H | HUMMOCKY | U | UNDULATING | D | DOMED BOG | N | DELTA MARSH |
| I | INCLINED | T | TERRACED | F | FLAT BOG | O | COASTAL MARSH |
| L | LEVEL | C | GILGAI | P | PLATEAU BOG | Q | FLOODPLAIN MARSH |
| R | ROLLING | M | MOUNDED | V | VENEER BOG | W | FLOODPLAIN SWAMP |
| E | RIDGED | A | APRON | J | RIBBED FEN | X | BASIN SWAMP |

11 SLOPE GRADIENT, %: 01, 04, 10, 16, 30, 60,
12 SLOPE LENGTH, M: 001, 050, 150, 300, 600
13 STONINESS, M APART: 00.1 00.2 00.8 01.6 10.0 30.0
14 ROCKINESS OUTCROPS, M APART:
H01, H04, H10, H35, H99
S01, S04, S10, S35, S99
15 DEPTH TO GROUND WATER, CM:

| | | | |
|---|---|---|---|
| AL100 | ALWAYS <100 | AG100 | ALWAYS >100 |
| TL100 | TEMPORARILY <100 | ML50 | MOTTLING <50 |
| AG100 | ALWAYS 100 - 200 | MG50 | MOTTLING >50 - 100 |
| TG100 | TEMPORARILY 100 - 200 | MG100 | MOTTLING >100 |

16 QUALITY OF GROUND WATER, MICROMHO: 0001, 0250, 0750, 1500, 3000
17 ROOTING DEPTH WHICH IS UNRESTRICTED, CM: 001, 025, 050, 100, 150

18 PREDOMINANT LAND USE/VEGETATION TYPE:

| | | |
|---|---|---|
| HORTICULTURAL | PLANTATION | SHIFTING CULTIVATION |
| ORCHARD | BUSH, GRAZING | URBAN |
| ANNUAL CROP | FOREST, NATURAL | IRRIGATED CROP |
| BOG, FEN | DESERT | IRRIGATED HORTICULTURAL |
| SWAMP | QUARIES, MINES | IRRIGATED ORCHARD |
| PASTURE, CULTIVATED | ROCK, RUBBLE | |
| GRASS NATIVE | RECREATION, OUTDOOR | |

CLOSED FOREST - UNSPECIFIED(FU), EVERGREEN(FE), SEMI-DECIDUOUS(FS)
- DECIDUOUS(FD), XEROMORPHIC(FX)

WOODLAND - UNSPECIFIED(WU), EVERGREEN(WE), SEMI-DECIDUOUS(WS)
- DECIDUOUS(WD), XEROMORPHIC(WX)

SHRUB - UNSPECIFIED(SU), EVERGREEN(SE), SEMI-DECIDUOUS(WS)
- DECIDUOUS(SD), XEROMORPHIC(SX)

DWARF/SHRUB - UNSPECIFIED(DU), EVERGREEN(DE), SEMI-DECIDUOUS(DS)
- DECIDUOUS(DD), XEROMORPHIC(DX)

HERBACEOUS - UNSPECIFIED(HU), TALL GRASS(HT), MEDIUM(HM)
- SHORT(HS), FORB(HF)

19 FLOODING ON SURFACE DUE TO INUNDATION(I) OR HIGH WATER TABLE(H)
IHO, I01, I02, I04, I07, I10
H01, H02, H04, H07, H10

20 CRUSTING ON SURFACE OR SEALING: UNSLAKED, PARTLY SLAKED, SLAKED, CAPPED

21 SURFACE DRAINAGE OR RUN OFF: POND, SLOW, MEDIUM, RAPID, VERY RAPID

22 OVERWASH OF EROSION PRODUCTS, % OCCUPANCE: 01, 03, 10, 40, 75

23 OVERBLOW OF EROSION PRODUCES, % OCCUPANCE: 01, 03, 10, 40, 75

24 WATER EROSION STATUS:

| | RILLS | | SHALLOW GULLIES | | DEEP GULLIES | |
|---|---|---|---|---|---|---|
| | DEPTH(CM) | DISTANCE(M) | DEPTH(CM) | DIST(M) | DEPTH(CM) | DIST(M) |
| A | <10 | >50 | | | | |
| B | <10 | 20-50 | | | | |
| C | <10 | <20 | 25-100 | 20-50 | | |
| D | <10 | <20 | 25-100 | <20 | >100 | 20-50 |

E LAND DESTROYED BY GULLY EROSION
S SHEET EROSION
N NON ERODED

25 WIND EROSION STATUS:
A 0-1% AREA AFFECTED
B 1-5% AREA AFFECTED
C PART OF A HORIZON REMOVED: BLOW OUTS, 0-5 CM DEEP ON 10-40% OF AREA
D ALL OF A HORIZON REMOVED. BLOWOUTS, 5-15 CM DEEP ON 40-75% OF AREA
E BLOWOUTS >15CM DEEP ON >75% OF AREA
R RIPPLES ON SOIL SURFACE

26 COMPLEXITY OF PARENT MATERIAL/SOIL: LOW, MEDIUM, HIGH

27 PERMAFROST DISTRIBUTION: SPORADIC, DISCONTINUOUS, CONTINUOUS

28 ICE CONTENT OF MATERIALS: LOW, MEDIUM, HIGH

SUMMARY SOIL LAYER ATTRIBUTE LIST AND CLASS CODES

01 COUNTRY CODE:
02 STATE/PROVINCE CODE:
03 BASE MAP CODE:
04 REPORT/MAP NUMBER CODE:
05 POLYGON NUMBER:
06 TERRAIN COMPONENT NUMBER IN WHICH DESCRIBED SOIL OCCURS(1-3)
07 POSITION ON SLOPE: SUMMIT, SHOULDER, MIDSLOPE, FOOTSLOPE, TOESLOPE, DEPRESSION, A
08 DRAINAGE: EXCESSIVE, RAPID, WELL, IMPERFECT, POOR, VERY POOR
09 PROPORTION OF POLYGON TO WHICH ATTRIBUTES APPLY, NEAREST 10%, OR 5% WHERE NEEDED:
10 PREVIOUS POLYGON NUMBER WITH SAME SOIL LAYER DATA
11 SOIL NUMBER OF ABOVE POLYGON RECORDED IN 10
12 SOIL NUMBER DESCRIBED WITHIN POLYGON (1-3):
13 LAYER/HORIZON NUMBER OF DESCRIBED SOIL (1-4:
14 LOWER DEPTH OF LAYER/HORIZON TO AT LEAST 150 CM: NOTE: TOP OF SURFACE LAYER IS 0 C
15 ABRUPTNESS OF LAYER/HORIZON BOUNDARY: ABRUPT, GRADUAL, DIFFUSE
16 DISTURBANCE OF SOIL: DISTURBED, UNDISTURBED
17 MOIST HUE COLOR: NOTE: LEFT JUSTIFY
18 MOIST VALUE COLOR:
19 MOIST CHROMA COLOR:
20 DRY HUE COLOR: NOTE: LEFT JUSTIFY
21 DRY VALUE COLOR:
22 DRY CHROMA COLOR:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 23 | ORGANIC CARBON, %: | 0.1 | 0.3 | 0.7 | 2.0 | 3.0 | 8.0 | 17.0 |
| 24 | NITROGEN TOTAL, %: | 0.01 | 0.1 | 0.2 | 0.5 | 1.0 | | |
| 25 | CEC TOTAL: | 01 | 03 | 06 | 13 | 30 | 36 | |
| 26 | CEC CLAY: | 0.1 | 1.5 | 6.0 | 17.0 | 24.0 | 37.0 | |
| 27 | CEC EFFECTIVE: | 0.1 | 1.5 | 2.0 | 5.0 | 10.0 | | |
| 28 | ANION EXCHANGE CAPACITY; | 0.10 | 0.25 | 0.50 | 1.0 | | | |
| 29 | CA EXCHANGEABLE: | 0.01 | 0.04 | 1.0 | 3.0 | 6.00 | 12.00 | 20.00 |
| 30 | MG EXCHANGEABLE: | 0.01 | 0.03 | 0.07 | 0.11 | 3.10 | | |
| 31 | NA EXCHANGEABLE: | 0.01 | 0.05 | 0.10 | 1.00 | 5.00 | | |
| 32 | K EXCHANGEABLE: | 0.01 | 0.06 | 0.20 | 0.30 | 8.00 | | |
| 33 | MN EXCHANGEABLE: | 0.01 | 0.06 | 0.11 | 1.10 | 2.00 | | |
| 34 | AL EXCHANGEABLE | 0.1 | 0.6 | 1.6 | 2.6 | | | |
| 35 | CA/MG RATIO: | 01 | 03 | | | | | |
| 36 | CA/K RATIO: | 01 | 05 | | | | | |
| 37 | MG/K RATIO: | 0.1 | 0.5 | | | | | |
| 38 | AL SATURATION: | 01 | 10 | 50 | 75 | | | |

39 AVAILABLE P

| | BRAY II | TRUOG | OLSEN |
|---|---|---|---|
| A | <3 | <2 | <1 |
| B | 3-5 | 2-4 | 1-2 |
| C | 5-7 | 4-5 | 2-3 |
| D | 7-12 | 5-15 | 3-6 |
| E | >12 | >15 | >6 |

40 P FIXATION: PRESENT, ABSENT, POSSIBLE, UNLIKELY
41 AVAILABILITY S: DEFICIENT, SATISFACTORY
42 TRACE ELEMENT DEFICIENCY: PROBABLE, POSSIBLE, UNLIKELY
43 TOXICITY POTENTIAL: PROBABLE, POSSIBLE, UNLIKELY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 44 | BASE SATURATION, %: | 01 | 10 | 25 | 50 | 75 | |
| 45 | PH WATER: | 0.1 | 3.9 | 5.5 | 6.5 | 8.4 | 9.1 |
| 46 | PH CACL: | 0.1 | 3.6 | 5.1 | 6.6 | 8.5 | 9.1 |
| 47 | ELECTRICAL CONDUCTIVITY MMHOS/CM: | 01 | 05 | 09 | 16 | 26 | 50 |
| 48 | ESP, %: | 01 | 09 | 16 | 26 | 40 | |
| 49 | CACO3 EQUIV: PRIMARY(P) | P00 | P01 | P06 | P15 | P40 | |
| | SECONDARY(S) | S00 | S01 | S06 | S15 | S40 | |

50 GYPSUM: 01 03 06 10 25 40

51 CLAY MINERALOGY: KAOLINITIC, MONTORILLONITIC, ILLITIC, VERMICULITIC, CHLORITIC, MIXED, ALLOPHANE, CARBONITIC, OXIDIC, GYPSIC

52 COARSE FRAGMENTS, % VOL: 01, 03, 15, 40, 80

53 TEXTURE, CLASSES (USDA):

| | | | | |
|---|---|---|---|---|
| | S | VGS | GL | SCL |
| 54 SAND TOTAL, %: | GLS | CB | CBGL | VCL |
| 55 VFSAND %: | LS | CBSL | CBL | CL |
| 56 SILT, %: | LFS | SL | L | SICL |
| 57 CLAY, %: | FS | FSL | GSIL | SC |
| 58 AVUP, KPa: | VS | GFSL | VFSL | GSIC |
| 59 AVLO, KPa: | LVFS | GSL | SIL | C |
| 60 AWCU, VOLUME %: | GS | VGSL | GCL | HC |
| 61 AWCL, VOLUEM %: | | | | |

62 BULKDENSITY, G/CM$^3$: 0.10 0.80 0.96 1.20 1.50 1.80

63 INFILTRATION, CM/H: 0.1 0.60 15.0

64 SATURATED HYDRAULIC CONDUCTIVITY, CM/H: 0.1 0.6 15.0

65 STRUCTURE:

- 01 SINGLE GRAIN, WEAK FINE SUBANGULAR BLOCKY; WEAKLY COHERENT POROUS MASSIVE
- 02 MODERATE FINE TO MEDIUM SUBANGULAR BLOCKY, WEAK FINE TO MEDIUM ANGULAR BLOCKY; WEAK TO MODERATE CRUMB; MODERATE TO STRONGLY COHERENT POROUS MASSIVE;
- 03 MODERATE COARSE SUBANGULAR BLOCKY; MODERATE FINE TO MEDIUM ANGULAR BLOCKY; STRONG CRUMB; WEEK FINE TO MEDIUM PRISMATIC; MODERATE COARSE PLATY.
- 04 STRONG COARSE SUBANGULAR BLOCKY; STRONG FINE TO MEDIUM ANGULAR (+ NUTTY/POLYHEDRIC) BLOCKY; MODERATE COARSE ANGULAR BLOCKY; MODERATE FINE TO MEDIUM PRISMATIC; WEAK COARSE PRISMATIC; NON-POROUS MASSIVE.
- 05 STRONG COARSE ANGULAR BLOCKY; MODERATE TO STRONG COARSE PRISMATIC; COLUMNAR; MODERATE TO STRONG PLATY.

66 AGGREGATES, STABLE, % RETAINED BY US STANDARD SEIVE NUMBER 20:

67 DECOMPOSITION DEGREE: FIBRIC, MESIC, HUMIC

68 BIOLOGICAL ACTIVITY: NONE, FEW, COMMON, MANY (ABUNDANCE OF ROOTS)

69 CONTRASTING LAYER:

| CODE | CLASS | CODE | CLASS |
|---|---|---|---|
| A | CLAY | I | SATURATED |
| B | CLAY LOAM-LOAM | J | INDURATED |
| C | SAND | P | PLINTHITE |
| D | GRAVEL CEMENTED BY GIBSITE | K | THIN CEMENTED |
| E | COMPACTED MAN MADE | L | CEMENTED BY ORGANIC MATTER, FE, AL |
| F | COMPACTED BASAL MORAINAL | M | FRAGIPAN |
| G | CONSOLIDATED ACID ROCK | N | CLAY PAN |
| H | CONSOLIDATED BASIC ROCK | X | NOT PRESENT |

70 DIAGNOSTIC HORIZON/FEATURE:

| | | |
|---|---|---|
| MOLLIC A | CAMBIC B | ALBIC E |
| FIMIC A | SPODIC B (PODZOLIC B) | CRYIC FROZEN PERMANENTLY |
| UMBRIC A | OXIC B | GLEYED STRONGLY OR REDUCED |
| OCHRIC A | CALCIC | VERMIC |
| ARGILLIC B | GYPSIC | VERTIC |
| NATRIC B | SULPHURIC | ANDIC |

71 DIAGNOSTIC HORIZON DEFINED IN: TAXONOMY, FAO, NATIONAL

72 DEVELOPMENT OF SOIL

| | | | |
|---|---|---|---|
| HISTIC | FERRALIC | LIXIC | CALCIC |
| VERTIC | STAGNIC | GLEYIC | CAMBRIC |
| ANDIC | NITIC | HALIC | MODER |
| PODZIC | LUVIC | CHERNIC | ANTHRIC |
| | | | PRIMIC |

73 REFERENCE PEDON NUMBER:

# SOTER CODING FORM 1 POLYGON FILE ATTRIBUTES + TERRAIN COMPONENT ATTRIBUTES SHEET 1

| | COUN | STAT | BASE | REPO | POLY | REGI | RELI | ELEV | LITH | LAKE | INUN | DIST | DENS | LAND | PROP | TERR | PARE | GROU | FORM | SLOP | LENG | STON | ROCK | DEPT | QUAL | ROOT | LUSE | FLOO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | 01 | 02 | 03 | 04 | 05 | 6 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 06 | 7 | 08 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |

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# SOTER CODING FORM 1 (CONTINUED) TERRAIN COMPONENT ATTRIBUTES

SHEET 2

| CRUS | SDRA | WASH | BLOW | WATE | WIND | COMP | PERM | ICE |
|---|---|---|---|---|---|---|---|---|
| 1–4 | 5–8 | 9–10 | 11–12 | 13 | 14 | 15 | 16 | 17 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |

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# SOTER CODING FORM 2 SOIL LAYER ATTRIBUTES

SHEET 1

| COUN | STAT | BASE | REPO | POLY | TERR | POSI | DRAI | PROP | PPOL | SNUM | SOIL | LALE | LOWE | ABRU | DIST | MHUE | MVAL | MCHR | DHUE | DVAL | DCHR | CARB | NITR | CEC | CECC | CECE | ANIO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 02 | 03 | 04 | 05 | 6 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |

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SOTER CODING FORM 2 SOIL LAYER ATTRIBUTES SHEET 2

| | CA | MG | NA | K | MN | AL | CAMG | CAK | MGK | ALSA | AVAP | PFIX | AVAS | TRAC | TOXI | BSAT | PHW | PHC | ELEC | ESP | CACO | GYPS | MINE | COAR | TEXT | SAND |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| 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 | | | | | | | | | | | | | | | | | | | | | | | | | | |

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# SOTER CODING FORM 2 SOIL LAYER ATTRIBUTES

SHEET 3

| VFS | SILT | CLAY | AVUP | AVLO | AWCU | AWCL | BULK | INFI | SATU | STRU | AGGR | DECO | BIOL | CONT | DIAG | DEFI | DEVE | PEDO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 |

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SOTER FORM 1

POLYGON AND TERRAIN COMPONENT ATTRIBUTES

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C  S B   R   P   R R  E  L  L I D  D L  P T P G F S L  S   R  D  Q  R  C  F C  S  W B W W C P I
O  T A   E   O   E E  L  I  A N I  E A  R E A R O L E  T   O  E  U  O  O  L R  D  A L A I O E C
U  A S   P   L   G L  E  T  K U S  N N  O R R O R O N  O   C  P  A  O  V  O U  R  S O T N M R E
N  I E   O   Y   I I  V  H  E N T  S D  P R E U M P G  N   K  T  L  T  E  O S  A  H W E D P M

CANA SA 72H  721  0105 P  27 575 GLAC 0 #   5 L ANNU 90 1 LA C U 01 150 30  #  AG99 0750 150 AN #  #   RAPI 10 10 C C L # #

CANA SA 721  721  0163 P 110 590 GLAC 1 #   0 L ANNU 90 1 LA C U 01 150 10  S3 AG99 0750 150 AN #  #   RAPI 10 10 C C M # #

CANA SA 721  721  0166 P 107 600 GLAC 0 #   1 L ANNU 90 1 LA L U 10 030 30  S3 AG99 0750 150 AN OCC # RAPI 10 10 D C M # #

CANA SA 721  721  0168 P  30 590 GLAC 0 #   3 L ANNU 90 1 FL L U 01 150 30  S3 AG99 0750 150 AN #  #   RAPI 03 03 B B H # #
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# SOTER FORM 2

## SOIL LAYER ATTRIBUTES

| COUN STAI BASE | REPO | POLY | POSI | DRAI | PROP PPOL | SNUM SOIL LAYE LOWE | ABRU DIST MHUE | MVAL MCHR DHUE | DVAL DCHR CARB | NITR | CEC CA | MG | NA | K | CAMG CAK MGK | BSAT PHW | ELEC CACO MINE | COAR TEXT | SAND VFS SILT CLAY SATU | STRU AGGR DECO | BIOL | CONT DIAG | DEFI DEVE | PEDO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CANA SA 72H | 721 | 0105 | DEP | POOR | 10 | 2 1 10 | AB UN 10YR | 3 1 10YR | 4 1 2.0 | 0.20 | 36 6.00 | 3.10 | 0.10 | 0.30 | 03 06 0.6 | 75 6.6 | 01 P00 MONT | HC | 2 1 22 76 | 03 | FEW | | NAT G | RRE109 |
| CANA SA 72H | 721 | 0105 | DEP | POOR | 10 | 2 2 20 | GR UN 10YR | 5 2 10YR | 6 1 2.0 | 0.20 | 36 6.00 | 3.10 | 0.10 | 0.30 | 03 06 0.6 | 75 6.6 | 01 P00 MONT | HC | 2 23 75 | 03 | FEW | GLEY | NAT G | RRE109 |
| CANA SA 72H | 721 | 0105 | DEP | POOR | 10 | 2 3 38 | GR UN 10YR | 4 1 10YR | 5 1 2.0 | 0.20 | 36 6.00 | 3.10 | 0.10 | 0.30 | 03 06 0.6 | 75 6.6 | 01 P00 MONT | HC | 2 20 79 | 04 | FEW | GLEY | NAT G | RRE109 |
| CANA SA 72H | 721 | 0105 | DEP | POOR | 10 | 2 4 150 | GR UN 10YR | 5 1 10YR | 6 1 0.3 | 0.01 | 36 6.00 | 3.10 | 0.10 | 0.30 | 03 06 0.6 | 75 6.6 | 01 P01 MONT | HC | 1 1 18 81 | 02 | FEW | GLEY | NAT G | RRE109 |
| CANA SA 721 | 721 | 0163 | MID | WELL | 40 | 3 1 20 | AB UN 10YR | 3 3 10YR | 4 3 2.0 | 0.20 | 13 6.00 | 3.10 | 0.10 | 0.30 | 03 06 0.6 | 75 6.6 | 01 P01 MONT | SICL | 15 11 47 37 | 02 | FEW | MOLL | NAT H | RTU114 |
| CANA SA 721 | 721 | 0163 | MID | WELL | 40 | 3 2 33 | AB UN 10YR | 3 4 10YR | 4 4 0.7 | 0.10 | 36 6.00 | 3.10 | 1.00 | 0.30 | 01 06 0.6 | 75 6.6 | 01 P01 MONT | C | 11 10 28 61 | 03 | FEW | NATR | NAT H | RTU114 |
| CANA SA 721 | 721 | 0163 | MID | WELL | 40 | 3 3 53 | GR UN 10YR | 5 3 10YR | 6 3 0.1 | 0.01 | 13 6.00 | 3.10 | 1.00 | 0.30 | 01 06 0.6 | 75 6.6 | 01 P16 MONT | SIC | 3 2 48 49 | 03 | FEW | CALC | NAT H | RTU114 |
| CANA SA 721 | 721 | 0163 | MID | WELL | 40 | 3 4 150 | GR UN 2.5Y | 5 4 10YR | 6 3 0.1 | 0.01 | 13 6.00 | 3.10 | 1.00 | 0.30 | 01 06 0.6 | 75 6.6 | 01 P07 MONT | SIC | 6 3 47 47 | 02 | FEW | CALC | NAT H | RTU114 |
| CANA SA 721 | 721 | 0166 | ALL | WELL | 80 | 1 1 15 | AB UN 10YR | 2 2 10YR | 4 2 2.0 | 0.20 | 13 6.00 | 3.10 | 0.10 | 0.30 | 03 06 0.6 | 75 6.6 | 01 P00 MONT | L | 34 30 47 19 | 03 | FEW | MOLL | NAT C | REL105 |
| CANA SA 721 | 721 | 0166 | ALL | WELL | 80 | 1 2 38 | GR UN 10YR | 4 4 10YR | 5 4 0.7 | 0.10 | 13 6.00 | 3.10 | 0.10 | 0.30 | 01 06 0.6 | 75 6.6 | 01 P00 MONT | CL | 31 30 34 35 | 03 | FEW | ARGI | NAT C | REL105 |
| CANA SA 721 | 721 | 0166 | ALL | WELL | 80 | 1 3 150 | GR UN 2.5Y | 5 3 2.5Y | 6 2 0.1 | 0.01 | 13 6.00 | 3.10 | 0.10 | 0.30 | 01 06 0.6 | 75 6.6 | 01 P07 MONT | SCL | 2 2 64 34 | 02 | FEW | CALC | NAT C | REL105 |
| CANA SA 721 | 721 | 0166 | ALL | WELL | 20 | 2 1 13 | AB UN 10YR | 2 2 10YR | 4 2 0.7 | 0.10 | 13 6.00 | 3.10 | 0.10 | 0.30 | 03 06 0.6 | 75 6.6 | 01 P00 MONT | SL | 66 43 15 20 | 02 | FEW | MOLL | NAT C | RBR104 |
| CANA SA 721 | 721 | 0166 | ALL | WELL | 20 | 2 2 33 | GR UN 10YR | 3 2 10YR | 4 3 0.7 | 0.10 | 13 6.00 | 3.10 | 0.10 | 0.30 | 03 06 0.6 | 75 6.6 | 01 P00 MONT | SCL | 64 56 11 25 | 03 | FEW | CAMB | NAT C | RBR104 |
| CANA SA 721 | 721 | 0166 | ALL | WELL | 20 | 2 3 150 | GR UN 2.5Y | 4 2 2.5Y | 5 2 0.1 | 0.01 | 13 6.00 | 3.10 | 0.10 | 0.30 | 01 06 0.6 | 75 6.6 | 01 P07 MONT | SL | 71 42 7 22 | 03 | FEW | CALC | NAT C | RBR104 |
| CANA SA 721 | 721 | 0168 | ALL | WELL | 70 | 1 1 18 | AB UN 10YR | 3 2 10YR | 4 2 3.0 | 0.20 | 13 6.00 | 0.10 | 0.10 | 0.30 | 03 06 0.6 | 75 6.6 | 01 P01 MONT | LS | 83 5 10 7 | 02 | FEW | MOLL | NAT C | RBI102 |
| CANA SA 721 | 721 | 0168 | ALL | WELL | 70 | 1 2 46 | GR UN 10YR | 4 3 10YR | 5 3 0.3 | 0.01 | 06 3.00 | 0.11 | 0.10 | 0.30 | 03 06 0.6 | 75 6.6 | 01 P16 MONT | S | 90 6 6 4 | 03 | FEW | CAMB | NAT C | RBI102 |
| CANA SA 721 | 721 | 0168 | ALL | WELL | 70 | 1 3 150 | GR UN 10YR | 5 3 10YR | 6 3 0.1 | 0.01 | 06 3.00 | 0.11 | 0.10 | 0.30 | 03 06 0.6 | 75 6.6 | 01 P16 MONT | S | 95 3 2 3 | 01 | FEW | CALC | NAT C | RBI102 |
| CANA SA 721 | 721 | 0168 | ALL | WELL | 20 | 2 1 13 | AB UN 10YR | 2 2 10YR | 4 2 0.7 | 0.10 | 13 6.00 | 3.10 | 0.10 | 0.30 | 03 06 0.6 | 75 6.6 | 01 P00 MONT | SL | 66 43 15 20 | 02 | FEW | MOLL | NAT C | RBR104 |
| CANA SA 721 | 721 | 0168 | ALL | WELL | 20 | 2 2 33 | GR UN 10YR | 3 2 10YR | 4 3 0.7 | 0.10 | 13 6.00 | 3.10 | 0.10 | 0.30 | 03 06 0.6 | 75 6.6 | 01 P00 MONT | SCL | 64 56 11 25 | 03 | FEW | CAMB | NAT C | RBR104 |
| CANA SA 721 | 721 | 0168 | ALL | WELL | 20 | 2 3 150 | GR UN 2.5Y | 4 2 2.5Y | 5 2 0.1 | 0.01 | 13 6.00 | 3.10 | 0.10 | 0.30 | 01 06 0.6 | 75 6.6 | 01 P07 MONT | SL | 71 42 7 22 | 03 | FEW | CALC | NAT C | RBR104 |
| CANA SA 721 | 721 | 0168 | ALL | WELL | 10 | 3 1 30 | AB UN 10YR | 3 1 10YR | 4 2 0.7 | 0.10 | 06 6.00 | 0.11 | 0.10 | 0.30 | 03 01 0.6 | 75 6.6 | 01 P00 MONT | LS | 86 23 6 8 | 02 | FEW | MOLL | NAT C | RAS103 |
| CANA SA 721 | 721 | 0168 | ALL | WELL | 10 | 3 2 91 | GR UN 10YR | 4 3 10YR | 4 2 0.3 | 0.01 | 06 3.00 | 0.11 | 0.10 | 0.30 | 03 01 0.6 | 75 6.6 | 01 P00 MONT | LS | 84 19 8 8 | 03 | FEW | CAMB | NAT C | RAS103 |
| CANA SA 721 | 721 | 0168 | ALL | WELL | 10 | 3 3 150 | GR UN 10YR | 5 6 10YR | 6 6 0.3 | 0.01 | 06 3.00 | 0.11 | 0.01 | 0.30 | 01 06 0.6 | 75 6.6 | 01 P00 MONT | LS | 86 23 4 10 | 01 | FEW | CALC | NAT C | RAS103 |

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GLOSSARY

Correlog refers to a log of Correlation activities pertinent to SOTER Projects

| | | |
|---|---|---|
| Parent material | - | refers to the unconsolidated mass from which the soil has developed. |
| Parent rock | - | refers to the rock from which the parent material was formed by weathering. |
| Igneous rock | - | rock solidified from magma may be extrusive on the earth's surface (volcanic) or intrusive into the rocks forming the crust of the earth. |
| Sedimentary rock | - | rock formed from material derived from pre-existing rocks by processes of denudation, together with material of organic origin. |
| Grits | - | sedimentary rock consisting of coarse sandstone with angular grains. |
| Arkose | - | sedimentary rock consisting of sandstones with more than 25% feldspar grains, relatively rich sandstones. |

Graywackes - sedimentary rock consisting of fine to coarse, angular to sub-angular particles, which are mainly rock fragments.

Conglomerate - sedimentary rock consisting of gravels.

Schist - a strongly foliated crystalline rock formed by dynamic metamorphism which can be readily split into thin flakes or slabs due to well developed parellelism of more than 50% of the minerals present, particularly those of lamellar or elongate prismatic habit (i.e. mica, hornblende)

Pyroclastic rocks - consist of materials which on having been thrown out of the volcano as liquid globules, has solidified in the air and is subsequently deposited as solid particles such as bombs, pumice (vesicular material derived from acidic lava) or scoriae (vesicular material derived from basic lavas).

Pyroclastic rocks also consists of material which has been thrown out of the volcano a solid fragment by the explosive activity including unconsolidated ashes (which consolidate to tuffs less than 2 cm diameter), breccia (agglomerated ashes greater than 2 cm diameter)

Landsat Spectral Bands and their Principal Applications are shown below:

| Satellite/Sensor | Band | Wavelength (Microns) | Applications |
|---|---|---|---|
| LANDSAT: MULTISPECTRAL SCANNER (MSS) Resolution: 80 cm | 1 | 0.5-0.6 | Coastal water (turbidity) mapping etc. |
| - do - | 2 | 0.6-0.7 | Useful to distinguish topographical and cultural features; to classify different types of vegetation; mapping of non-vegetated areas, guilies, dry channels, sandy areas, etc. |
| - do - | 3 | 0.7-0.8 | Rock-soil boundary differentiation; landuse changes detection; estimation of green biomass. |
| - do - | 4 | 0.8-1.1 | Demarcation of land/water boundaries; soil-crop moisture studies; surface water bodies mapping; mapping of geological features. |
| LANDSAT THEMATIC MAPPER (TM) Resolution: 30 m | 1 | 0.45-0.52 | Coastal water (turbidity) mapping; soil mapping; deciduous/coniferous flora discrimination; mapping of cultural features. |
| - do - | 2 | 0.52-0.60 | Measurement of visible green reflectance peaks of vegetation for vigour assessment. |
| - do - | 3 | 0.63-0.69 | Mapping of vegetation types and subtypes; discrimination of vegetated and non-vegetated areas. |
| - do - | 4 | 0.76-0.90 | Determining biomass content and for delineating water bodies. |
| - do - | 5 | 1.55-1.75 | Vegetation/soil moisture content and snow/cloud differentiation. |
| - do - | 6 | 10.40-12.50 | Vegetation stress analysis, soil moisture studies and thermal mapping. |
| - do - | 7 | 2.08-2.35 | Discrimination of rock types (mineral and petroleum geology) and hydrothermaly altered zones. |