our land resources



Our Land Resources

a bulletin to accompany

New Zealand Land Resource Inventory Worksheets

produced for the

National Water and Soil Conservation Organisation

by the

Water and Soil Division, Ministry of Works and Development

Wellington, New Zealand
© Crown copyright
1979

As chairman of the National Water and Soil Conservation Authority I know well the soundness of the legislative and policy frameworks that the National Water and Soil Conservation Organisation uses in guiding wise land use and water management strategies.

The Organisation has, in applying its policies nationwide, placed considerable emphasis on assembling and presenting facts about the land at a uniform scale and standard. Completion of this task is enabling understandings of the complex nature of our land resources to increase; better decisions and policies can be expected to follow.

The New Zealand Land Resource Inventory Worksheets are an outstanding achievement which I commend to you. They give the first national picture of our land resources at a reasonably detailed scale. Few countries in the world have accomplished a national coverage of this type. From foundations established over many years by staff serving the National Water and Soil Conservation Authority and catchment authorities, it has been possible to accomplish a national coverage in only four years. I commend this achievement by those concerned and am pleased to see that already the information is assisting in a wide range of decisions on planning and management at all levels.

Two features distinguish the worksheet information. Firstly, it is an integrated presentation of the five powerful basic controls that underlie land use — rock type, soil, slope, vegetation and erosion — on the one 'map'. Secondly, these factors are grouped in such a way that the user is presented with resource 'units' or 'parcels' of land which have essentially uniform characteristics. These are also assessments of the land's capability for a variety of uses.

An associated milestone has been the development of New Zealand's first computer-based land resource data storage and retrieval system. It is based on the worksheet information. Users have the choice of using this system or of using information directly from the worksheets, according to their needs.

Thanks are expressed to all those organisations and individuals whose material contributions of information and advice have made this nationwide survey possible.

Bill Young.

W. L. Young
Minister of Works and Development



Contents

page

9 **HISTORICAL BACKGROUND**

11 **OBJECTIVES OF THE NATIONAL LAND RESOURCE SURVEY**

12 **HOW THE NATIONAL SURVEY WAS MADE**

- Mapping Technique
  - Aerial Photograph Interpretation
  - Field Work

14 **PRESENTATION OF SURVEY INFORMATION**

- Worksheets
- Worksheet Legends
- Extended Legends
- Soils Appendix
- Computer Information
  - Tabulations
  - Map Presentation
  - Graphic Presentation

27 **EXPLANATION OF LAND RESOURCE INVENTORY**

- Rock Type
- Soil
- Slope
- Erosion
- Vegetation

32 **EXPLANATION OF LAND USE CAPABILITY**

- Assumptions
- Capability Classification

34 **ILLUSTRATED DESCRIPTION OF CAPABILITY CLASSES**

- Class I
- Class II
- Class III
- Class IV
- Class V
- Class VI
- Class VII
- Class VIII

42 **ILLUSTRATED DESCRIPTION OF CAPABILITY SUBCLASSES**
43 **ILLUSTRATED DESCRIPTION OF CAPABILITY UNITS**
44 **WAYS TO APPLY THE LAND RESOURCE INFORMATION**
- Computer and Manual Alternatives
- Inventory Applications
  - Single Factor
  - Multi-Factor
- Capability Applications
  - Capability Class
  - Capability Subclass
  - Capability Unit
- Combined Inventory and Capability Applications

57 **WHERE TO APPLY THE LAND RESOURCE INFORMATION**
- Land Use Planning at Different Levels
  - National Planning
  - Regional Planning
  - District Planning
  - Catchment or Mountain Range Planning
- Land Use Planning for Different Purposes
  - Agriculture
  - Forestry
  - Rural Valuations and Property Transactions
- Assessing Production Potentials

72 **ADVICE FOR USING WORKSHEETS**
73 **GLOSSARY OF TERMS**
76 **VEGETATION — BOTANICAL NAMES**
77 **REFERENCES**
78 **ACKNOWLEDGEMENTS**

Enquiries for information

— General Enquiries

Director of Water and Soil Conservation
Ministry of Works and Development
P.O. Box 12-041
WELLINGTON NORTH

— North Island Worksheets

The Secretary of the appropriate Catchment Authority:
Northland Catchment Commission, P.O. Box 886, Whangarei.
Auckland Regional Water Board, Private Bag, Auckland.
Waikato Valley Authority, P.O. Box 4010, Hamilton East.
Hauraki Catchment Board, P.O. Box 7, Te Aroha.
Bay of Plenty Catchment Commission, P.O. Box 364, Whakatane.
Poverty Bay Catchment Board, P.O. Box 649, Gisborne.
Hawke's Bay Catchment Board, P.O. Box 233, Napier.
Wairarapa Catchment Board, P.O. Box 41, Masterton.
Taranaki Catchment Commission, P.O. Box 159, Stratford.
Rangitikei/Wanganui Catchment Board, P.O. Box 92, Marton.
Manawatu Catchment Board, P.O. Box 2043, Palmerston North.
Wellington Regional Water Board, P.O. Box 11-245, Wellington.

or Scientist-in-Charge
Aokautere Science Centre
Ministry of Works and Development
Private Bag
PALMERSTON NORTH

— South Island Worksheets

The Secretary of the appropriate Catchment Authority:
Nelson Catchment Board, P.O. Box 41, Nelson.
Marlborough Catchment Board, P.O. Box 204, Blenheim.
North Canterbury Catchment Board, P.O. Box 788, Christchurch.
South Canterbury Catchment Board, P.O. Box 160, Timaru.
Westland Catchment Board, P.O. Box 66, Greymouth.
Waitaki Catchment Commission, P.O. Box 110, Kurow.
Otago Catchment Board, P.O. Box 858, Dunedin.
Southland Catchment Board, P.O. Box 408, Invercargill.

or Scientist-in-Charge
Christchurch Science Centre
Ministry of Works and Development
P.O. Box 1479
CHRISTCHURCH

— Accessing Computer-Stored Land Resource Information

Send written requests via Catchment Authorities to Palmerston North or Christchurch addresses as above, or telephone: for North Island — 67-154 Palmerston North; for South Island 791-200 Christchurch.

— Refer to back outer cover for worksheet numbers

Historical background

Those who travel through the mountainous parts of Europe are attracted by the harmony that exists between man and the land.

Centuries of trial and error have enabled this close relationship to be attained. During that time there have been many and extensive examples of failure: of soil erosion and accompanying river deterioration.

The Europeans who helped to settle North America did not always apply the lessons they had learned so painstakingly in their own countries. Misuse of unfamiliar soils and the effects of unknown climates on land use often led to serious deterioration in their new land. Adverse trends are, however, being reversed. One of the basic tools devised to assist with and measure this reversal is the land use capability classification and mapping system.

When New Zealand in its turn began to experience widespread and severe soil erosion in the wake of drastic vegetation changes, land use capability mapping had already been thoroughly tested in the United States of America. It was, therefore, brought into use very soon after the introduction of the 1941 Soil Conservation and Rivers Control Act which, for the first time, provided the statutory basis for the country to deal with its soil erosion. L. W. McCaskill in his history of soil conservation in New Zealand — "Hold This Land" — gives a good account of its application.

Used at first for individual farm and run plans, catchment authorities soon employed land use capability mapping to help them examine problems in complete catchments or regions. With the passing of the 1967 Water and Soil Conservation Act and the subsequent setting up of the Water Resources Council, the need was seen to study current land use, land use capability and water management throughout complete catchments and river systems, as land use and water quantity and quality constitute an indivisible trio.

Because of the use being made of the resulting land use capability maps, the Soil Conservation and Rivers Control Council decided to complete the survey for the whole of the country. Although the decision was made for the purpose of assisting the National Water and Soil Conservation Organisation it was also timely because of subsequent developments in connection with local government planning, urban expansion and the rural problems facing counties in their regional plans.

Of the various regions, Poverty Bay - East Coast is notorious for the disintegration of some soft and shattered mudstone and sandstone formations under agricultural use. The extent and severity of soil erosion and the effect of this on streams and rivers prompted the Soil Conservation and Rivers Control Council to institute a detailed analysis of the consequences. The group conducting the analysis was headed by a pedologist, Dr N. H. Taylor, Director of the Soil Bureau, Department of Scientific and Industrial Research. He was naturally well aware of the basic importance of soils, but was even more conscious of the many other factors to be assessed in determining the capability of the land: what caused the deterioration and what were the safe uses? The scheme for rehabilitation accepted by Government included large scale afforestation. When finally implemented it will bring about great changes in the stability of land and lead to economic and social betterment of the region. The basis of it all is land use capability.

On a regional scale, the system has recently been used in the Upper Kaituna (the catchment of Lake

Rotorua) and the Lake Taupo catchment control schemes. Both have been designed to halt pollution of lake waters which are prized both nationally and internationally. In addition the lake basins or catchments have important economic, recreational and scenic values. Nowhere in this country is the interrelationship between land use and water management better illustrated or of greater significance. For example, downstream of Taupo, the Waikato River flows through 320 kilometres (200 miles) of channel, services eleven power generation plants, several major industries and numerous urban and rural communities. The management of the Lake Taupo water resource thus has effects far beyond the basin itself.

In the South Island there is now a general awareness of the danger of continuous stocking of Class VIII and some Class VII land. To maintain the best water yields and condition of rivers, the vegetation of the mountains must be healthy.

The importance and suitability of detailed land resource mapping in providing a basis for district planning has been realised. For instance, detailed mapping can reveal the extent to which urban development is encroaching on some of the best agricultural soils, it can also reveal unstable hill soils, geological structures unsuitable for urbanisation, and low-lying areas subject to flooding. Many of the problems that have appeared in cities and towns are bound to increase in the future if these assessments are not made and taken note of in planning.

The closest marriage between land resource mapping and local government planning has been achieved in the recent Hamilton Regional Planning Scheme. To quote from the scheme itself:

"A set of eight rural resource policy areas has been defined each sharing some basic characteristics or problem and needing particular forms of management or protection.

Four of these proposed policy areas form a hierarchy based on land use capability classes . . . The main concern of these new regional policy areas . . . is to prevent the misuse of the region's valuable natural resources and wherever practicable to ensure that lands will be permanently available for the purposes for which they are best suited . . ."

In both rural and urban communities there is a prime need for the intelligent management of soil and water resources. While such management is at present divided between local authorities and catchment boards, there is likely to be a drawing together of these interests under the revised Town and Country Planning Act.

Decisions as to land use have become increasingly complex because of all the pressures being applied to both public and private land. Capability classification is one tool that can be used to simplify decisions.



A. L. Poole
Chairman
Soil Conservation and Rivers Control Council
(1971-78)

Objectives of the National Land Resource Survey

The National Land Resource Survey serves NWASCO* in its responsibilities for development of catchments and promotion of wise land use. The survey also has much wider use. For the implementation of the Town and Country Planning Act it provides regional and local authorities with comprehensive information about the land they are responsible for.

The survey also assists in resolving many other matters. Examples are:

- landscape architects may wish to identify areas of landscape interest beside a main highway . . .
- foresters may wish to know where they can haul logs using wheeled vehicles . . .
- food processing companies with a view to expanding business interests, may wish to know where prime arable land is . . .
- government may wish to set primary production targets . . .
- catchment authorities may wish to know which land could be drained to increase production . . .
- rural valuation or real estate firms may wish to find, for clients, areas with good development prospects . . .
- farm machinery manufacturers may wish to know how much land has stones and boulders on it that could be removed . . .
- producer boards may be interested in comparing present and potential production on different types of land . . .
- wildlife or environmental groups may wish to find areas of swampland vegetation around a lake margin that should be preserved . . .
- county planning consultants may wish to identify areas that could be put into forest as part of a district scheme . . .
- power board engineers may need to know details of the terrain over which they are to put a new power line . . .
- farm advisors may wish to comment on the economics of developing presently undeveloped land . . .

Until now, sources of information which could answer such questions were restricted, piecemeal, or in many cases, non-existent. While there have been many classifications of land for particular purposes (for example, soils, geology, vegetation, productivity, fertiliser response, erosion, etc) world-wide experience has shown that the best approach is to assess all of these factors (and more) together when considering the land's capacity for sustained production.

This has been done in the National Land Resource Survey so that it provides a coverage of land resource information for the whole of New Zealand. It is at a scale detailed enough for use at regional and district levels, but can also be widely used for national planning purposes. It complements many other surveys at more detailed scales made by catchment authorities who use the same techniques of land classification.

* National Water & Soil Conservation Organisation

How the national survey was made

Mapping Technique

The National Land Resource Survey has been carried out for the National Water and Soil Conservation Organisation by land resource scientists in the Water and Soil Division of the Ministry of Works and Development.

These scientists are qualified in one or more of the subjects of geology, earth science, botany, forestry, geography and agriculture. They work together in teams so that their complementary professional skills make them able to assess the land in an integrated way.

This assessment is of 'land use capability' (LUC) which is an ordered arrangement of the land according to those properties that determine its capacity to sustain production permanently. The word 'capability' is used here to mean suitability for productive use after taking into account any physical limitations the land may have.

As a basis for the land use capability assessment, an inventory is made of the facts about the land. The facts recorded are: rock type, soil, slope, erosion degree and type, and vegetation. This information is then displayed on the New Zealand Land Resource Inventory Worksheets as land inventory units.

These units are areas of land which, in terms of the five physical factors mapped, have uniform characteristics. They are therefore 'homogeneous' for every factor, and are separated on the worksheets from adjoining, different units by a blue boundary line.

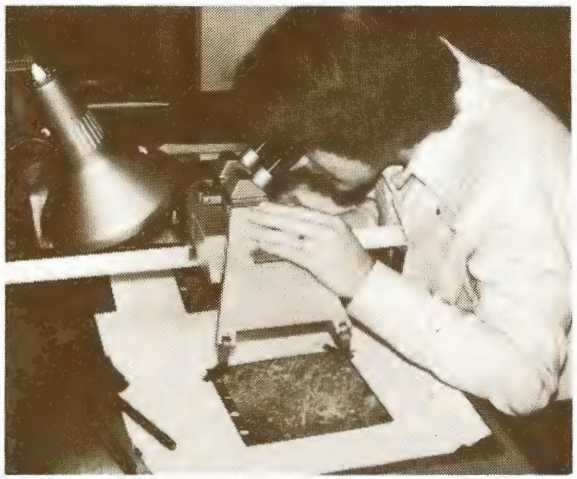
As used here, the terms 'homogeneous unit areas' and 'uniform physical characteristics' only apply at the scale of mapping of the worksheets, which is 1 inch to 1 mile (1:63,360). At any scale of mapping there is usually some variability within the units. In other words, there are likely to be small areas of 'other' kinds of land within the kind being mapped as they are too small to be identified as separate units.

The inventory and capability classification mapping processes involve both aerial photograph interpretation and field work. Information from surveys made by other organisations is also used after being checked in the field and in the office by the National Land Resource Survey scientists. Where the scales of mapping of these surveys differ from the scale used in the worksheet series, the scientists use their professional judgement to make new boundaries in terms of the aims of the National Land Resource Survey. Other information is gained through discussions with the staff of other organisations.

The land use capability assessment is not applied to urban areas as these have been taken out of primary productive use.

Aerial photograph interpretation

Aerial photographs are examined through stereoscopes by the scientists and major landform boundaries are drawn in. These boundaries are based on the factors of slope, soil and rock type, which generally determine the basic pattern of inventory units. Frequently these three sets of boundaries coincide but not always. Subdivision of these 'first order' units is made as the factors of erosion and vegetation are taken into account.



KEY:

"First order" boundaries (based on one or more of the factors of slope, soil and rock type). ——

"Second order" boundaries (based on vegetation and/or erosion). — — —



Aerial photography reproduced by permission of the Department of Lands and Survey, New Zealand

Field work

Extensive field work complements the aerial photograph information so that in making the National Land Resource Survey, the scientists have travelled over the whole of New Zealand, sometimes on foot, sometimes by motor vehicle, and sometimes by helicopter.

The land resource inventory provides an objective field measurement and record of those physical characteristics of the land that existed at the particular time each area was mapped.



Presentation of survey information

The National Land Resource Survey information is made available to users in three ways:
- on the New Zealand Land Resource Inventory Worksheets
- in the extended legends that accompany the worksheets
- as computer print-outs, or as additional multi-colour computer-drawn maps.

Worksheets

The worksheets show two sets of information over a modified NZMS 1 topographical base:

- a land resource inventory of five physical factors presented in code form. These are rock type, soil, slope, erosion and vegetation
- a land use capability assessment, also presented in a code form.

The worksheets contain, therefore, an integrated assessment of several factors on the one map in contrast to the more usual single factor assessment.

The worksheet format enables:
- rapid printing — to minimise delays between compilation and publication so that the information does not get out of date
- the display of information according to users' requirements
- easy updating when land characteristics (such as vegetation and erosion) change.

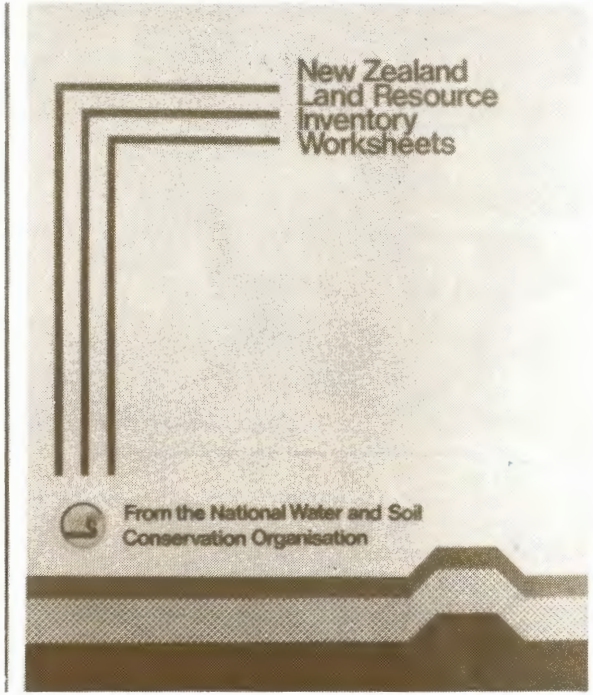
The worksheet scale of 1:63,360 was chosen because:

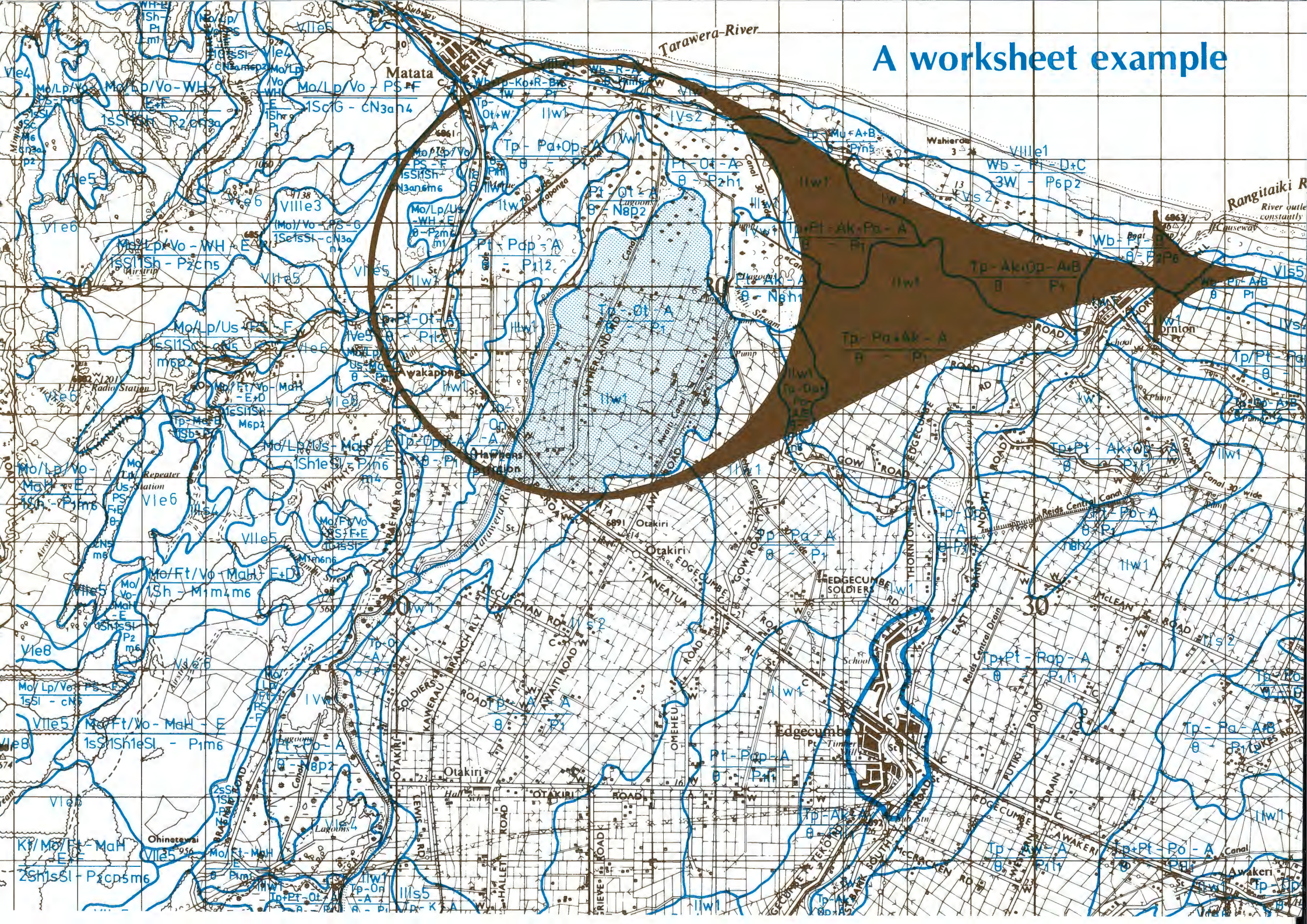
- it was the most detailed scale at which a rapid national coverage could be achieved
- it was the most detailed one for which a national set of base maps existed when the survey began
- it can satisfy planning requirements at many levels — national, regional and district.

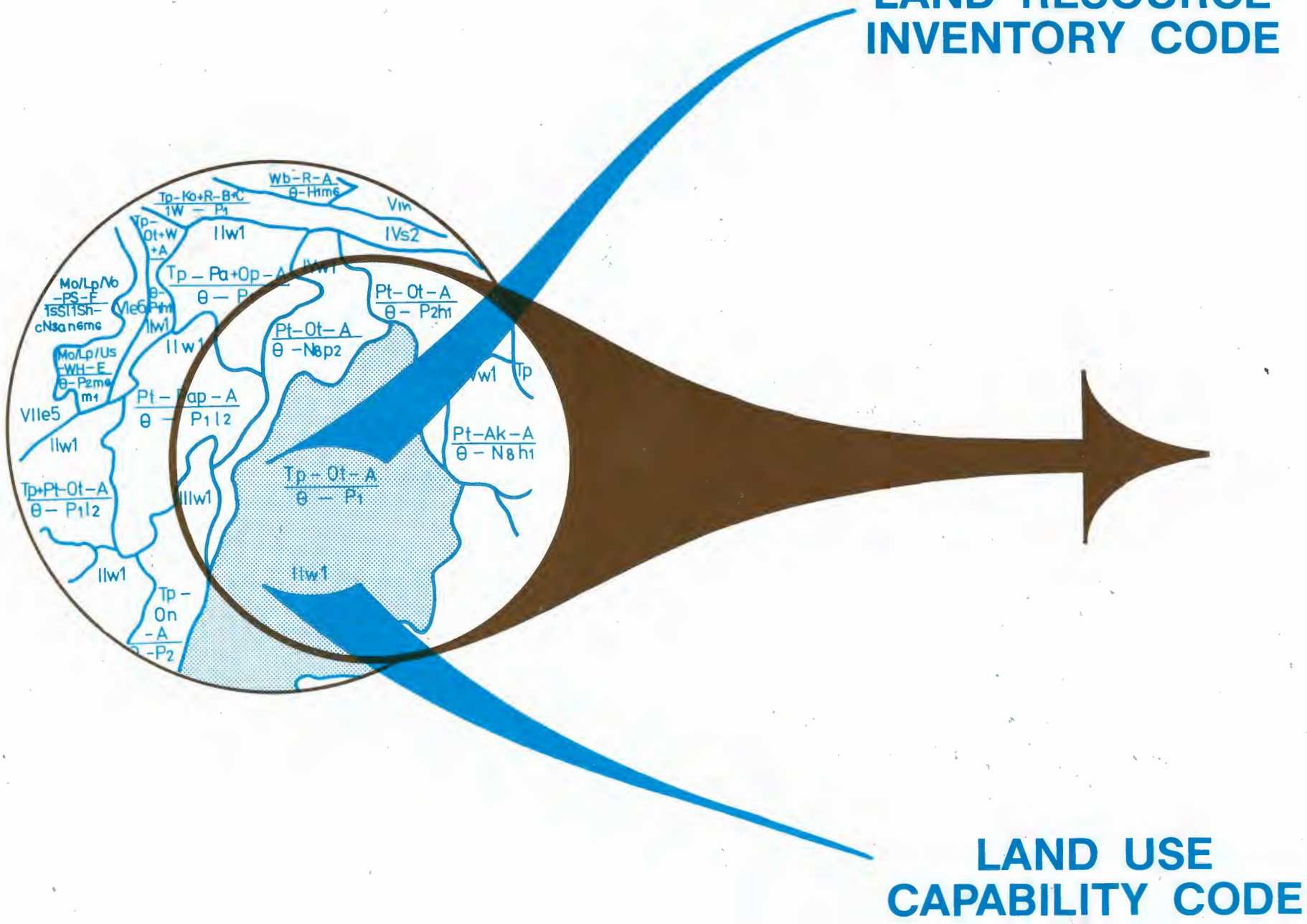
The term "worksheet" was chosen deliberately for the series to encourage use for many purposes. The worksheets can be cut up, coloured, etc., according to users' needs.

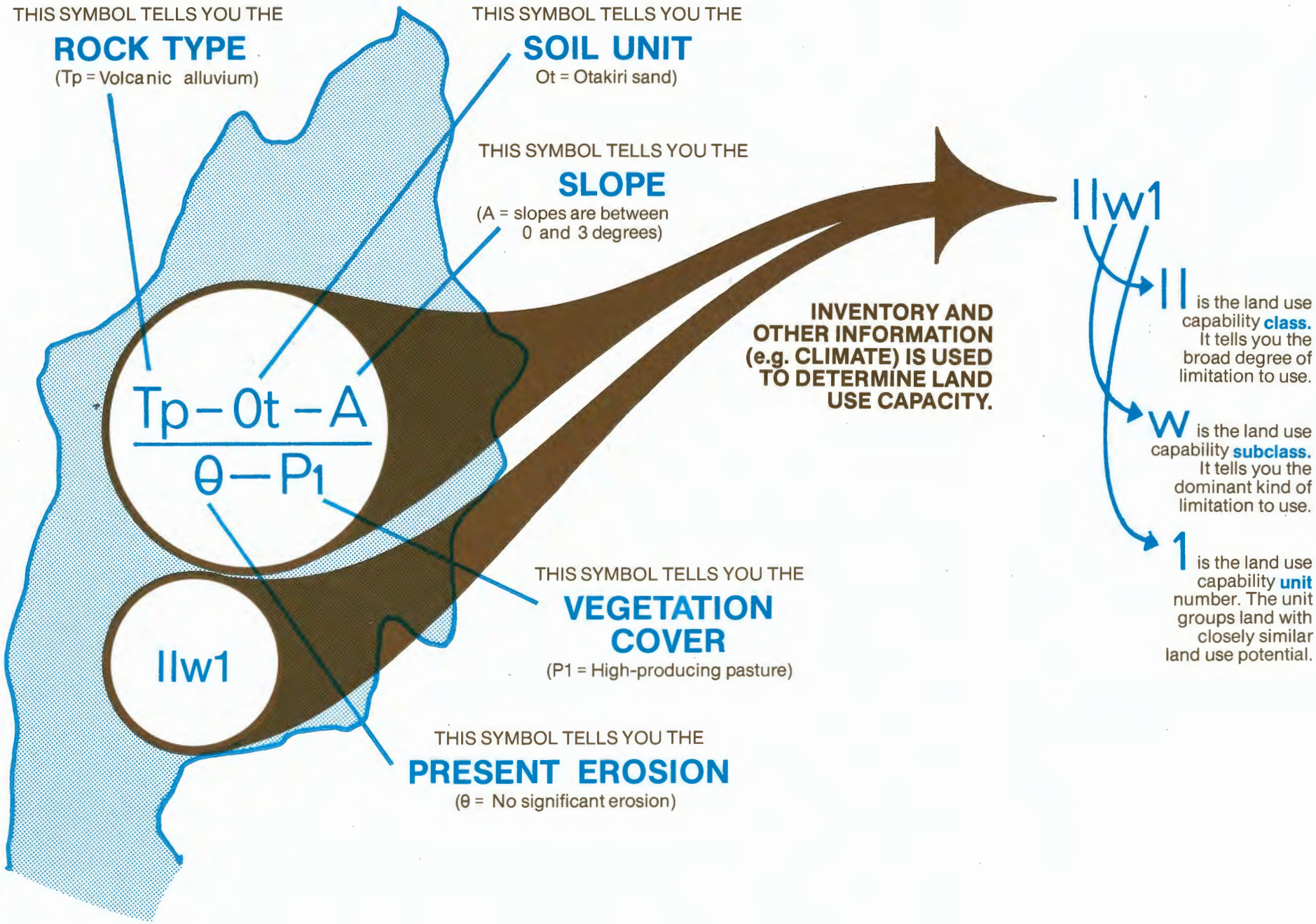
North Island worksheets are distributed from the Aokautere Science Centre at Palmerston North and the South Island worksheets from the Christchurch Science Centre (see page 8 for addresses and back cover for worksheet numbers).

Each set of worksheets is sent out in a folder (see below) which also contains an introduction and appendices.




A worksheet example
Tarawera River
Matata
Awakaponga
Otakiri
Edgecumbe
Rangitaiki R
Ohinetewai


LAND RESOURCE INVENTORY CODE
Wb-R-A / θ-Hm6
Tp-Ko+R-B+C / 1W — P1
Vm
IVs2
IIw1
Tp — Pa+Op-A / θ — P
Pt-Ot-A / θ — P2h1
Pt-Ot-A / θ -N8p2
Tp
Pt — Pap — A / θ — P1 l2
Pt-Ak-A / θ — N8 h1
VIIe5
IIw1
Tp+Pt-Ot-A / θ — P1 l2
IIIw1
Tp — Ot — A / θ — P1
IIw1
IIw1
Tp — On — A / θ -P2
LAND USE CAPABILITY CODE


THIS SYMBOL TELLS YOU THE
ROCK TYPE
(Tp = Volcanic alluvium)
THIS SYMBOL TELLS YOU THE
SOIL UNIT
Ot = Otakiri sand)
THIS SYMBOL TELLS YOU THE
SLOPE
(A = slopes are between 0 and 3 degrees)
Tp – 0t – A
θ – P1
IIw1
INVENTORY AND OTHER INFORMATION (e.g. CLIMATE) IS USED TO DETERMINE LAND USE CAPACITY.
IIw1
II is the land use capability class. It tells you the broad degree of limitation to use.
W is the land use capability subclass. It tells you the dominant kind of limitation to use.
1 is the land use capability unit number. The unit groups land with closely similar land use potential.
THIS SYMBOL TELLS YOU THE
VEGETATION COVER
(P1 = High-producing pasture)
THIS SYMBOL TELLS YOU THE
PRESENT EROSION
(θ = No significant erosion)

Worksheet legends

At the side of each worksheet is a legend which needs to be used to "decode" the symbols shown on the worksheets.

LEGEND

A INVENTORY CODE

Rock type – Soil unit – Slope
Erosion degree and type – Vegetation

ROCK TYPE

Volcanic Lithologies		Sedimentary Lithologies	
Ng	Ngauruhoe ash	Pt	Peat
Ta	Tarawera ash & lapilli	Wb	Sands–windblown
Rm	Rotomahana ash	Lo	Loess
Kt	Kaharoa & Taupo ashes	Al	Undifferentiated flood plain alluvium
Mo	Ashes older than Taupo ash	Gr	Gravels
Lp	Lapilli	Us	Unconsolidated silts, ashes, sands, tuffs & breccias
Tp	Taupo & Kaharoa breccia, & volcanic alluvium	Mm	Mudstone or fine siltstone–massive
Ft	Breccias older than Taupo breccia	Mb	Mudstone or siltstone – banded
La	Lahar deposits	Mj	Mudstone or siltstone – jointed
Vo	Welded volcanic rocks	Me	Mudstone – bentonitic
Gn	Crystalline intrusive rocks	Sm	Sandstone or siltstone – massive
		Sb	Sandstone – banded
		Ar	Argillite*
		Ac	Argillite* – crushed
		Li	Limestone
		Gw	'Greywacke'

Note:
* denotes deep weathering
(Al) significant in patches
Lo/Gw stratigraphic succession, surface rocks first

Rock Type adapted from: N.Z. Geological Survey Map 1:250.000 Sheet 5 Rotorua, 1st edition.

SOIL UNIT

Soil information and boundaries are based on soil maps supplied by Soil Bureau D.S.I.R. with additions from fieldwork and air photo interpretation:
D.S.I.R. 1954 General Survey of Soils of North Island, N.Z.
Soil Bureau Bulletin (n.s) 5.
•Rijkse W.C. (in prep.) 'Soils of Whakatane County' Soil Bureau D.S.I.R. Rotorua.

BR Bare Rock

SLOPE

A	0 – 3°	
B	4 – 7°	
C	8 – 15°	
D	16 – 20°	
E	21 – 25°	
F	26 – 35°	
G	> 35°	

ADDITIONAL SLOPE SYMBOLS

D/E	Average slope borderline between the two slope groups
A+B	Compound slopes. First slope group dominates
A	Dissected slopes

EROSION

TYPES OF EROSION		DEGREE OF EROSION	
Sh	– sheet	0	– negligible
W	– wind	1	– slight
Sc	– scree creep	2	– moderate
sSl	– soil slip	3	– severe
eSl	– earth slip	4	– very severe
Su	– slump	5	– extreme
daF	– debris avalanche		
eF	– earth flow	(For a more detailed description see Land Use Capability Handbook, p 18)	
mF	– mud flow		
R	– rill		
G	– gully		
T	– tunnel gully		
Sb	– streambank		
D	– deposition		

VEGETATION

GRASSLAND

P	Unspecified grassland	P3	'Short' tussock assns mainly silver & hard etc
P1	High producing pasture	P4	Snow tussock assns
P2	Low producing or native grassland	P5	Red tussock assns
		P6	Sand dune assns

CROPLAND

L	Unspecified crops	L3	Root & green fodder crops
L1	Cereals	L4	Horticulture
L2	Orchards & vineyards		

SCRUBLAND

M	Unspecified scrub assns	M6	Mixed native scrub assns
M1	Manuka, kanuka	M7	Broom
M2	Tauhinu (Cassinia)	M8	Gorse
M3	Dracophyllum	M9	Blackberry
M4	Fern	M10	Sweet briar
M5	Sub alpine scrub assns	M11	Matagouri
		M12	Mangroves

FOREST

N	Unspecified forest assns	N4	Nothofagus (a)Lowland (b)Highland
N1	Coastal forest	N5	Hardwood
N2	Kauri	N6	Exotic forest
N3	Podocarp-hardwood (a) Lowland (b)Mid altitude	N7	Podocarps
		N8	Conservation trees

WEEDS, HERBS ETC

H	Unspecified herbaceous plant assns	H4	Sub alpine herb assns
H1	Swamp assns	H5	Salt tolerant assns
H2	Rushes, sedges	H6	Pakihi
H3	Sand dune assns	H7	Semi-arid herbfield assns

Capital letter indicates type of vegetation comprises > 40% of unit area, small letter < 40%
c indicates cut-over forest

B LAND USE CAPABILITY ASSESSMENT

For classification refer to accompanying Bay of Plenty–Volcanic Plateau extended legend.

Inventory

As shown on the previous pages, the inventory factors — rock type, soil unit, slope, erosion degree and type, and vegetation — are set out in the form of a fraction:

$$\frac{\text{Rock type} — \text{Soil unit} — \text{Slope}}{\text{Erosion degree and type} — \text{Vegetation}}$$

On the worksheets this fraction is expressed in code form. For example:

$$\frac{\text{Tp} — \text{Ot} — \text{A}}{\theta — \text{P1}}$$

According to the worksheet legend this means:

Rock type — Tp = Volcanic alluvium

Soil unit — Ot = Otakiri sand

Slope — A = Dominant slopes are between 0° and 3° (that is, flat to gently undulating country).

Erosion degree and type — θ = Negligible erosion. (In other cases it will be noticed that there are two symbols for erosion. For example 2Sh; here '2' refers to the severity which is moderate and 'Sh' refers to the type which is sheet erosion. '2Sh' means therefore, moderate sheet erosion.)

Vegetation — P1 = High-producing pasture.

Note that in the worksheet legend the individual soils are not listed but a reference is given to the survey from which the soils information was obtained. Details of the soils are given in an appendix accompanying the extended legend (see page 23).

On those North Island worksheets that were published early in the series, the same situation applies to the rock type factor, as the survey from which the information was adapted is referenced. On the more recent North Island worksheets and on all the South Island worksheets, the lithological (rock type) classifications that have been developed especially for the worksheet series are listed in the worksheet legend. Ultimately all the earlier North Island worksheets will be changed to the lithological system.

Where the mapping scale does not allow any inventory factor to be shown singly (that is, where there are small areas of another type of one inventory factor present within the overall unit), compound factors are used. For example, areas of windblown sand containing pockets of peat would be shown as Wb + Pt. The dominant type is always recorded first.

Land use capability

The land use capability of any area is also represented as a code. Only the heading 'Land Use Capability' appears in the worksheet legend; the details of the classification are set out in the accompanying extended legend.

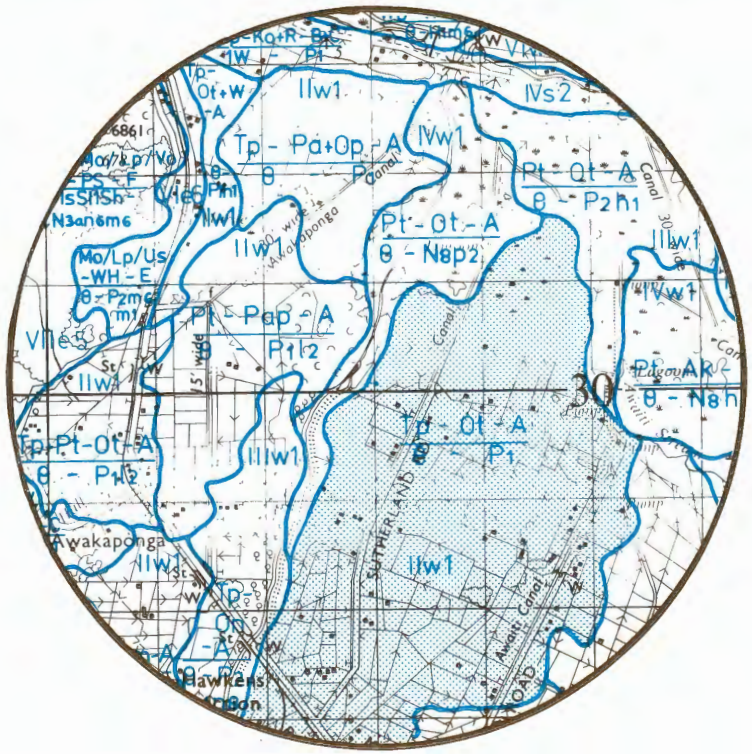
BAY OF PLENTY — VOLCANIC PLATEAU:

UNIT	UNIT DESCRIPTION	PRESENT LAND USE	GRAZING Carrying Capacity (su/ha)			CROPPING	FORESTRY	EXOTIC FOREST GROWTH POTENTIAL	FERTILISER REQUIREMENTS FOR PASTURE FOR SHEEP AND CATTLE GRAZING			
			Present Average	Top Farmer	Attainable Physical Potential				INITIAL	MAINTENANCE		
										At present average grazing capacity	At attainable physical potential grazing levels	Trace elements
IIw1	Flat river terraces near sea level with gley and gley recent soils. Occasional surface flooding and high winter water table levels limit versatility.	Dairying Cereal cropping	18	22	27	Cereal. Root and green fodder Horticultural	Production	40-41	800-900 kg/ha superphosphate	300 kg/ha 15% potassic super	450 kg/ha 15% potassic super	Copper. Cobalt.

* Provided by Ministry of Agriculture and Fisheries and represents best available information. It does not apply to dairying and cropping.

** Soil Survey '2': New Zealand Soil Bureau, Department of Scientific and Industrial Research: "Soils of Whakatane County" (in preparation).

Circle A



Extended legends

The Land Use Capability Extended Legend accompanying each set of worksheets, serves two main purposes:

a when read across the columns it summarises the key characteristics of each land use capability unit. For example, in Circle A for the shaded unit IIw1 the inventory can be interpreted as:

Tp = Volcanic alluvium
Ot = Otakiri sand
A = Flat to gently undulating slopes
θ = Negligible present erosion
P_1 = High-producing pasture

LAND USE CAPABILITY EXTENDED LEGEND

SLOPE	ROCK TYPE	TYPICAL SOILS		EROSION		VEGETATION	TYPE LOCALITY	SOIL CONSERVATION AND WATER MANAGEMENT MEASURES	ADDITIONAL COMMENTS
		Name & Symbol	Survey**	Present	Potential				
A	Volcanic alluvium. Tp Tephric alluvium and peat. Tp+Pt	Gley and gley recent Rewatu silt loam Re Paroa silt loam Pa Paroa silt loam on peat Pap Otakiri sand Ot	 2 2 2 2	Nil	Nil	High-producing pasture Cereal crops	N68/280290	—	Cropping versatility is limited by late planting dates and possible harvesting difficulties caused by wetness.

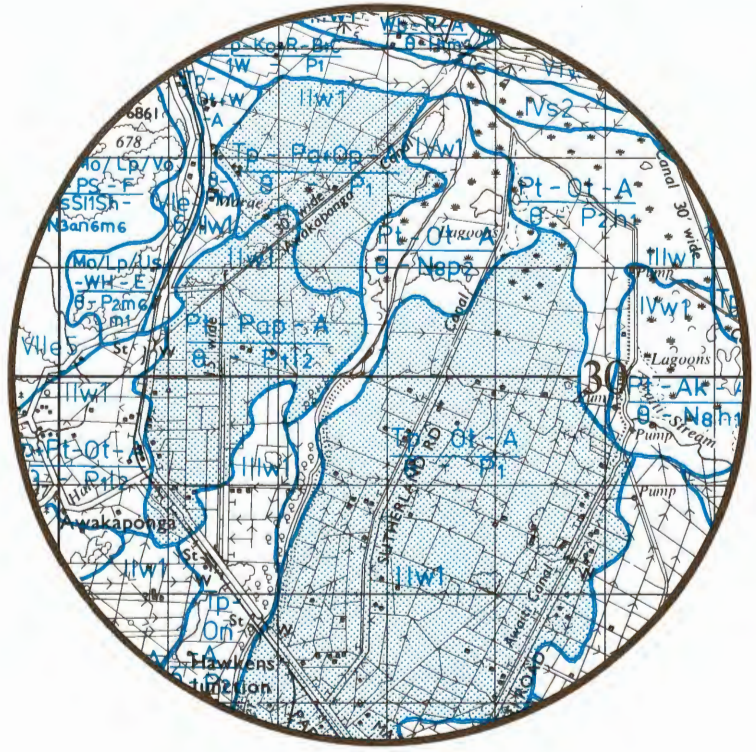
b it draws together land inventory units that vary slightly, but which are very alike in terms of their capability for use and their inherent potential use. For example, from Circle B it can be seen that an assessed land use capability of IIw1 has inventory units which include:

$$\frac{Tp — Ot — A}{\theta — P_1}$$

and $$\frac{Pt — Pap — A}{\theta — P_1 l_2}$$

and $$\frac{Tp — Pa + Op — A}{\theta — P_1}$$

That is, while slope and erosion have not changed, rock types, soils, and vegetation have, though not enough to affect the long term capability of the land.



Circle B

The extended legend also provides extra information which is not recorded in the worksheet inventory formulae. This is given under the following headings:

Unit description

This provides a general description of each land use capability unit and may include such information as altitudinal limits and climatic ranges.

Present land use

Much of this information reflects the vegetation cover which gives a good indication of present land use. However, other information may be provided such as the present average carrying capacity for grazing. This gives the number of stock units per hectare (su/ha) that an "average farmer" typically carries over the winter on that particular land use capability unit. Also given is the number of stock units per hectare which the farmer with the highest stocking rate but with at least average stock performance is carrying over the winter on that particular land use capability unit.

Potential land use

As defined here, potential land use merely lists the range of alternative uses possible for each land use capability unit in terms of physical characteristics only. It is not an expression of recommended land use and it does not involve factors such as location, remoteness, access, downstream effects, economics or social aspects. The attainable physical potential for grazing is given. This refers to the number of stock units per hectare that are capable of being carried over the winter on that particular land use capability unit, as assessed within the limits of present technology and assuming favourable socio-economic conditions apply. Potentials for exotic forestry growth are also given and are based on the site index for *Pinus radiata;* that is, the mean top height at age 20 years.

Fertiliser requirements for pasture maintenance

In the more recent extended legends, and ultimately in them all, an indication is given of the amounts and types of fertilisers needed to maintain pasture in good condition. These requirements refer to a sheep farming regime.

Potential erosion

An assessment is given of the potential erosion of each unit under an actual or assumed grassland cover with assumed average management and no soil conservation measures applied. (A derivative map series at a scale of 1:250,000 showing potential and present degrees and types of erosion, is also being prepared by Water and Soil Division land resource scientists. Several sheets have already been published.)

Type locality

A grid reference gives the location of a typical example of each land use capability unit.

Soil conservation measures

A guide is given to the kinds of soil conservation measures applicable to each land use capability unit.

There are eleven different land use capability extended legends covering New Zealand — ten regional ones for the North Island and one for the entire South Island. As national coverage of the worksheet series is achieved the ten regional legends will be combined into one to cover the entire North Island.

The ten North Island extended legends are:
Northland
Coromandel - Great Barrier
Waikato
Bay of Plenty - Volcanic Plateau
Eastern Bay of Plenty
Gisborne - East Coast
Northern Hawke's Bay
Taranaki - Manawatu
Wairarapa - Southern Hawke's Bay
Wellington

Soils appendix

In the worksheet legend the soil symbols shown in the inventory code are not explained, but a reference is given to the soil survey whose classification and naming for the various soil units was used in the compilation of the particular worksheet.

Explanation and details of the symbols are given as an appendix accompanying the worksheets.

In the appendix, soils are listed by soil unit name (for example, Pa — Paroa silt loam) in accordance with broad soils groupings such as "Yellow-brown sands" or "Gley soils and gley recent soils", etc. The parent material on which each soil has developed is also given.

An alphabetical or numerical index to soil symbols is provided where appropriate.

SOILS APPENDIX: BAY OF PLENTY — VOLCANIC PLATEAU

Soil Survey: Rijkse, W. C. (in prep) 'Soils of Whakatane County' Soil Bureau, D.S.I.R. Rotorua

SYMBOL	SOIL	PARENT MATERIAL
	YELLOW BROWN SANDS	
Ko	Kopeopeo loamy sand	Volcanic ash, volcanic ash on windblown sand
	ORGANIC SOILS	
Po	Pongakawa peaty sand	Volcanic ash on alluvium over peat
	GLEY SOILS AND GLEY RECENT SOILS	
Re	Rewata silt loam	Alluvium and colluvium
Ak	Awakaponga silt loam	Alluvium over volcanic ash and alluvium, over peat
Pa	Paroa silt loam	Shallow volcanic ash on alluvium and volcanic ash
Pap	Paroa silt loam on peat	Shallow volcanic ash on alluvium, volcanic ash and peat
On	Onepu sand	Shallow volcanic ash over pumiceous alluvium
Aw	Awakeri loamy sand	Volcanic ash on peat and pumiceous alluvium
Ot	Otakiri sand	Shallow volcanic ash on peat and pumiceous alluvium
	RECENT SOILS	
R	Rangitaiki gravelly sand and sand	Alluvium from greywacke and volcanic ash
Op	Opouriao fine sandy loam	Alluvium from greywacke and volcanic ash
Opm	Opouriao fine sandy loam and silt loam	Alluvium from greywacke and volcanic ash
A	Awaiti loamy sand	Volcanic ash on alluvium

(continued)



Inventory and capability codes are put into computer storage via a keyboard (above) while the area and position of each unit are stored by tracing the boundary with the digitising cursor (below).



Computer information

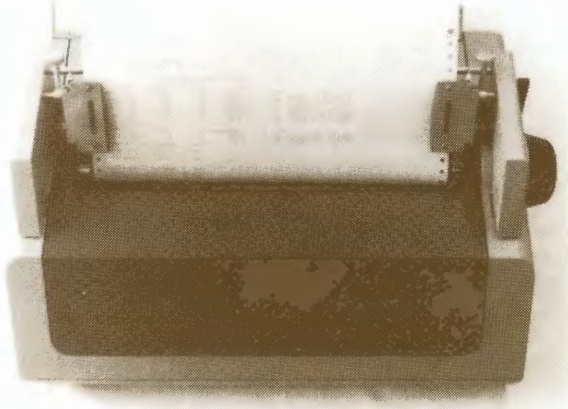
When using 'map type' information, the user is frequently faced with the time-consuming task of manually locating certain types of land, measuring their areas and sorting the required information. Therefore as a complementary service to the worksheet series, all the land resource information is being placed in computer storage at the Water and Soil Division's Land Resource Data Facilities at the Aokautere and Christchurch Science Centres. These electronic data processing developments have enabled the laborious, manual tasks to be eliminated when answering many types of requests.

Each 'land parcel' has its exact location, shape, area, physical characteristics (that is, inventory code), and capability ranking stored away. This information is then virtually at the users' fingertips to service specific requests, as the computer has the ability to sort through large volumes of information quickly.

Requests from organisations and groups generally assume the form of:

- how much land is suitable for a particular use?
- where is the land located?

With the help of the computer, the Data Facility can answer these questions. The computer must, however, be told the boundary of the area under investigation (such as a county or catchment) as well as the exact question/s to be answered. The user would normally supply the boundary together with the questions which would then be phrased in terms of the inventory and capability codes so that they may be answered by the computer.



The stored information can be displayed on either a character impact printer (above) or a programmable four-colour plotter (below).



The answers are available as:

- tabulations — lists of the locations (New Zealand grid co-ordinates), areas and kinds of land in question
- multi-colour computer-drawn maps — the required information is drawn by a programmable plotter to show precise shapes and locations. These can be at the same, or reduced, scales
- standard statistical functions — for example, graphs.

Tabulations

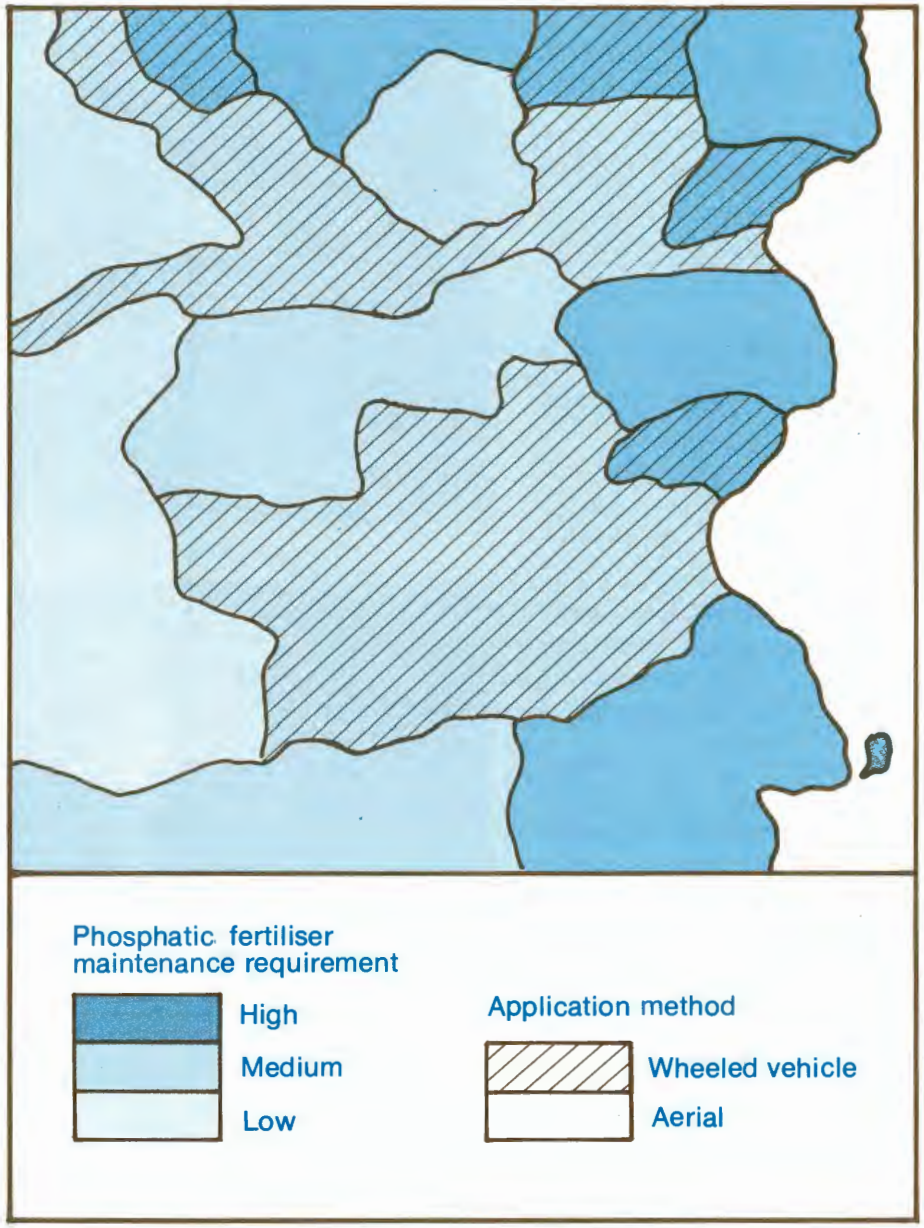
a Interpretive summaries. For example, a list of the areas of land (in hectares) with varying pastoral production potentials according to specific vegetation categories.

Pastoral Production Potential (su/ha)	Present Vegetative Cover (areas in ha)						
	Cutover bush	Manuka scrub	Cropland	High-producing pasture	Exotic forest	Indigenous forest	Total
<10	395	357	0	0	0	979	1,731
10-13	2,023	3,070	71	3,606	256	7,740	16,766
>13	1,468	1,313	281	4,853	0	9,601	17,516
Total	3,886	4,740	352	8,459	256	18,320	36,013

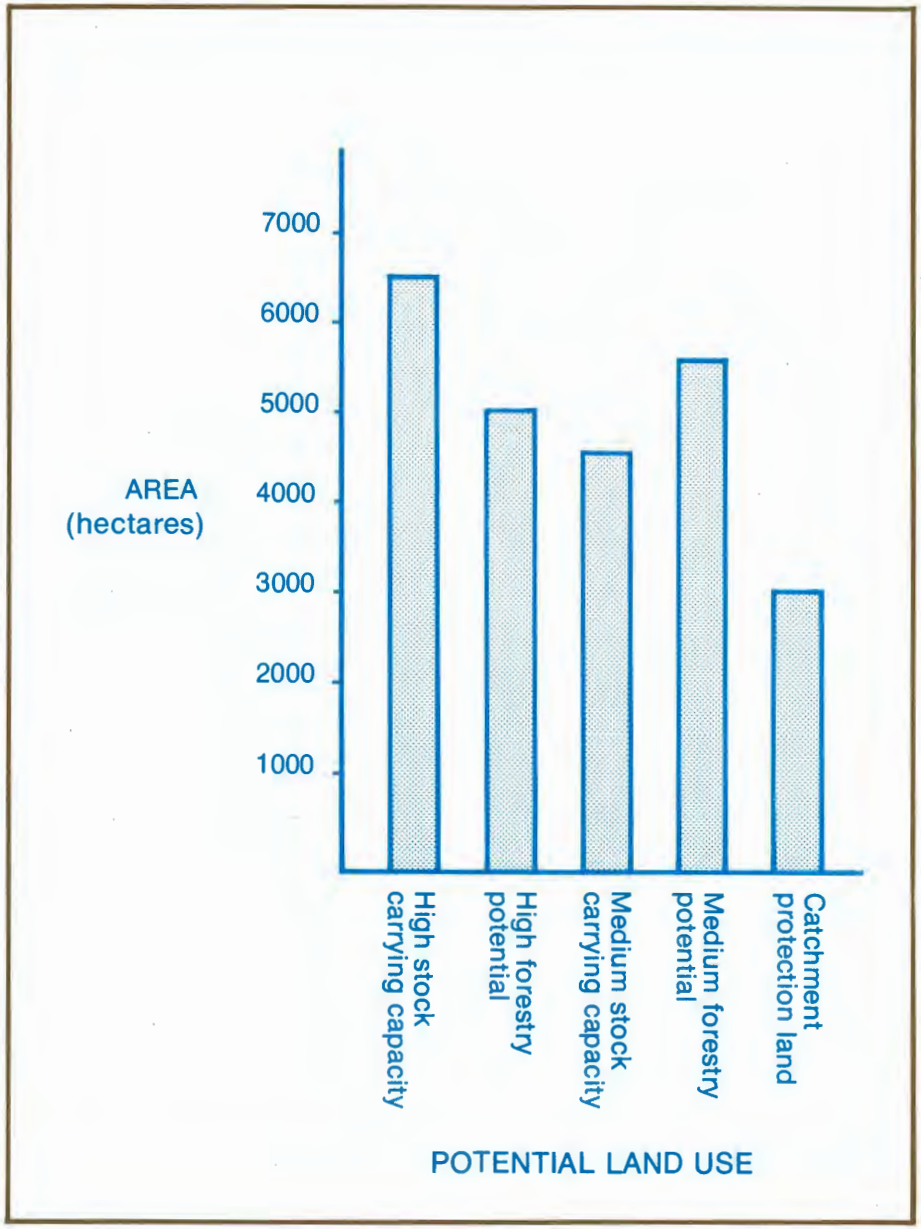
b Basic data. For example, a list of all areas with severe to extreme present erosion and dominantly pastoral cover, giving also, the land use capability classification.

Grid Ref	Area (ha)	Erosion	Vegetation	LUC
841925	200	3eF2G	P1h2	VIIe17
762728	417	4eF1G	P2h2	VIIe17
743550	308	3sS12Sh	P2m1m8	VIIe22
697277	91	3sS12Sh	P2m1n3a	VIIe22
650189	628	3sS11eF1G	P2m1	VIIe22
521090	111	3sS11Sh	P2n3a	VIIe22
491901	149	4sS11Sh	P2n5	VIIe6
304424	557	3Sh1sS1	P2m8	VIIe18

Map Presentation *(supplied as an overlay or on a base map)*



Graphic Presentation



Explanation of land resource inventory

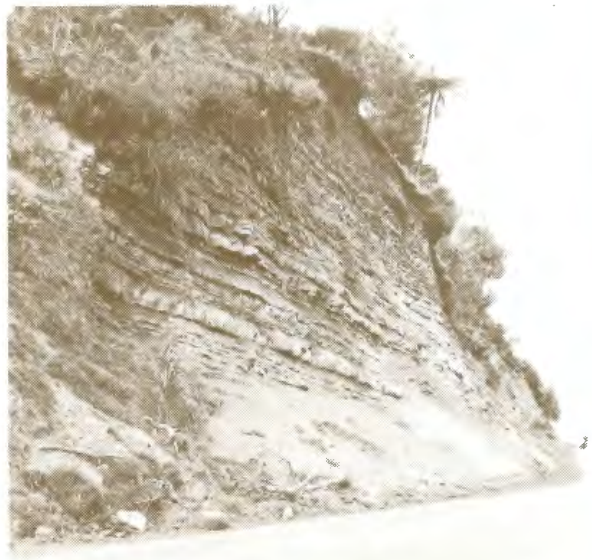
The following pages contain details about the individual factors of the land resource inventory.

Rock type

Simplified lithological (rock type) classifications have been developed especially for use in the worksheet series. This is because the information needed to solve soil conservation and water management problems is concerned not as much with the age of a rock in the geological time sequence, as it is with the properties of rocks and surface deposits, since it is these that affect land stability and water management. They are expressed simply so that they can be understood by the layman.

Separate classifications have been used in the North and South Islands because of their basic lithological differences. For example, volcanic deposits are limited in occurrence in the South Island, but their extensive distribution in the North Island requires more detailed classification.

Basic geological information is obtained from maps produced by the New Zealand Geological Survey, Department of Scientific and Industrial Research, primarily from the 1:63,360 and 1:250,000 Geological Map Series. The 1:63,360 series maps show and describe mainly rock units but as these maps cover only a part of New Zealand, extensive use has been made of the 1:250,000 series which is largely based on geological time units. It has therefore been necessary to modify and adapt the information from these geological surveys to take into account the geological factors which directly influence land stability and land use (for example, volcanic ash or loess cover) and to relate them to the worksheet lithological classification.





National Publicity Studios

On the worksheets the symbol ° or prefix 'w' denotes that the rock type is deeply weathered. Brackets around the rock type symbol, for example (Al), indicate that that rock type occurs only in patches in that unit.

Where there is a stratigraphic succession of rock types present, the surface rock is shown first as in the example Lo/Gw (loess over greywacke).



Soil

A combination of extensive field surveying, stereoscopic analysis of aerial photographs and use of existing soil surveys is used to identify and mark out the boundaries of soil units.

Over major areas of New Zealand, this mapping procedure provides more detailed delineation of soil boundaries than is currently available from existing soil surveys. However, for a relatively small proportion of the country, existing soil surveys are more detailed than appropriate for the worksheet series. In such areas, soil boundaries have had to be generalised and therefore show less detail than is included in the original soil maps.

Soil symbols and names are drawn from classifications used in publicly available soil surveys produced by the New Zealand Soil Bureau, Department of Scientific and Industrial Research. Since these have used different classifications over the years, each survey used is referenced in the worksheet legend.

Occasionally a distinctive soil has not been able to be described by any existing soil name and symbol. Therefore a new soil mapping unit has been created and the provisional name and symbol assigned to it has been given in the worksheet legend.

Appended to the extended legend is a soils listing which briefly outlines the characteristics and inter-relationships of each soil unit. It sets out symbols and names used in each survey according to broad soil groupings.(see page 23).



Slope

The angle of slope, or relief, of an area is measured with an abney level, or estimated visually, in the field and recorded as one of seven slope groups.

Slope Groups	Description	Landform Units
A (0-3°)	Flat to gently undulating	Floodplains, terraces
B (4-7°)	Undulating	Fans, gently sloping downs
C (8-15°)	Rolling	Downs, steep fans
D (16-20°)	Strongly rolling	Easy hill country, downs
E (21-25°)	Moderately steep	Hill country
F (26-35°)	Steep	Steep hill country, mountain lands
G (>35°)	Very steep	Very steep slopes, rock faces, cliffs

As with the other inventory factors, compound slopes may be recorded where more than one major slope grouping occurs in an otherwise uniform unit. For example, D+ E slopes means that slopes are mainly strongly rolling, but contain pockets of land with moderately steep slopes.

Slopes which are borderline between two slope groupings are recorded in the form D/E. A dash to the top right of the slope symbol indicates that the slopes are dissected. For example, A′ indicates that the land is virtually flat but is dissected by gullies or terrace edges.





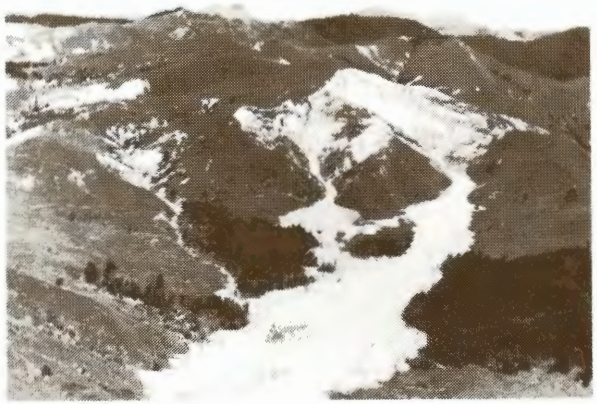
Erosion

Erosion results in a loss of the land resource and a disruption to land use and public utilities. It is a factor that must always be taken into account and its effects weighed against potential productivity, before proper decisions on long term land use or on the management of related bodies of water or public utilities can be made.

The worksheets record present erosion degree and the dominant types of erosion.

The fourteen erosion types mapped are based on the classification devised by Campbell (1951) because:

- the terms are those most commonly used by the rural community and its advisors
- it is based on New Zealand examples and best describes the complex erosion forms of the mass movements occurring on the North Island soft-rock hill country



Erosion types recorded are:

Sheet	Sh
Wind	W
Scree creep	Sc
Earth slip	eSl
Soil slip	sSl
Slump	Su
Earthflow	eF
Mudflow	mF
Debris avalanche	daF
Rill	R
Gully	G
Tunnel gully	T
Streambank	Sb
Deposition	D

Deposition, which has been brought about by erosion and flooding, requires special conservation and management practices. It is often an important component of the overall erosion scene and is therefore included in the erosion assessment, although it is not strictly an erosion type.

Erosion degree is recorded on a 0-5 scale. Sheet, wind and scree creep erosion are assessed on an areal basis according to the percentage of bare ground or eroding area within the inventory unit. The degree of the remaining erosion types is recorded on a "seriousness" basis which takes into account a combination of background factors such as rock type, rate and depth of movement, frequency of erosion events, feasibility and cost of control, and economic effect.

Severity of erosion	Symbol	Area of land affected (applies to wind, sheet and scree creep)
Negligible	0	Not significant
Slight	1	1-10%
Moderate	2	11-20%
Severe	3	21-40%
Very Severe	4	41-60%
Extreme	5	>60%

Erosion which is occurring at the time of the survey, or which has occurred and still exhibits surface expression in the form of bare ground, is mapped. Past erosion features which are now stable and/or revegetated are not mapped.



Vegetation

The worksheets provide the most detailed, currently available, national record of New Zealand's vegetation cover.

Knowledge of the vegetation cover provides information on present land use. It can indicate scope for future development as well as give an insight into problems that could result from changes of land use. It can also substantially influence the economics of development options.

On the worksheets, vegetation is first described by a letter which indicates the type of vegetation:

Symbol	Type
P, p	Grassland
L, l	Cropland
M, m	Scrubland
N, n	Forest
H, h	Miscellaneous associations

(A capital letter indicates that the vegetation group covers more than 40% of the inventory unit area. A small letter indicates a cover of less than 40%.)

Secondly, each vegetation type is accompanied by a number which indicates a specific association or species within that type. For example, scrubland is divided into twelve categories of which dracophyllum, fern, and subalpine scrub are examples.



Vegetation is therefore recorded on the worksheets in the form such as P1m8. Here, the capital 'P' indicates that grassland covers more than 40% of the unit, and subscript '1' that this is high-producing pasture. The small 'm' indicates that scrub covers less than 40% of the unit and the '8' that this is gorse. The vegetation for this unit, then, is high-producing pasture with some gorse.

Generally, only the three dominant vegetation types present in each inventory unit are recorded on the worksheets, although there may actually be more than three types present.

In some situations the prefix 'c' is used. This stands for 'cutover' and is used where the original indigenous forest structure has been altered by logging operations.

For example, a tract of virgin lowland podocarp hardwood forest would be represented on the worksheets as N3a. However, if this tract were selectively logged to extract a proportion of the podocarps, the forest type would be recorded as cN3a; that is, the forest has retained a lowland podocarp/hardwood type structure but some of the podocarp has been removed by logging.



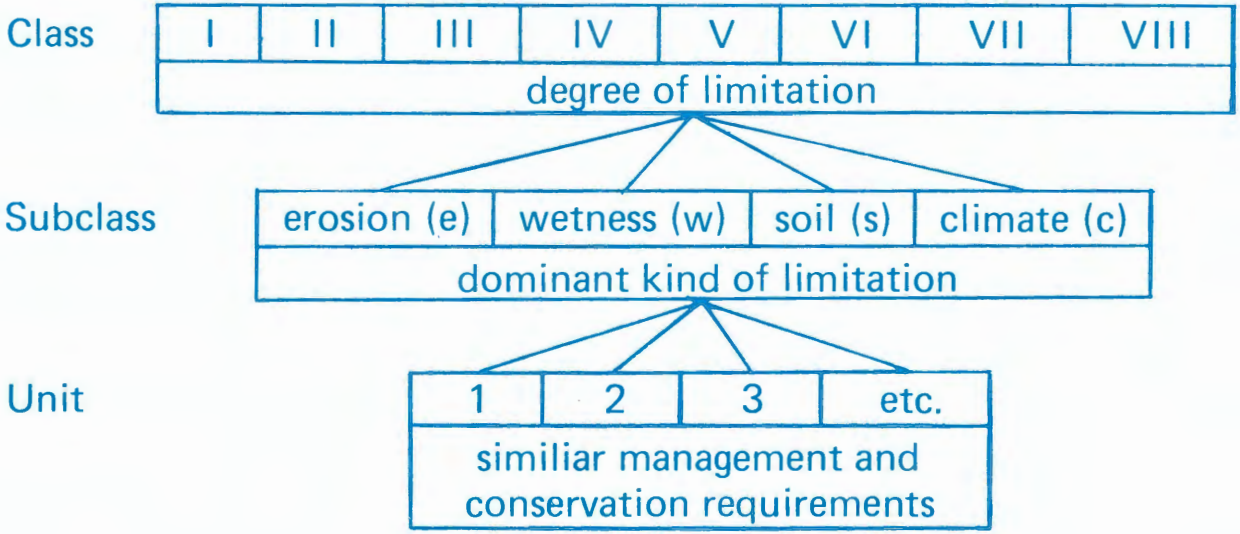
National Publicity Studios

Explanation of land use capability

Each land resource inventory unit on the worksheets is also assigned a second set of symbols such as IIe7 or VIIs2. This is an assessment of the unit in terms of its capacity for sustained productive use, taking into account physical limitations, management requirements and soil conservation needs. The assessment is based on an interpretation of the physical information in the inventory formula as well as additional information on climate, etc. Land Use Capability (LUC) must not be confused with present land use or recommended land use.

The LUC classification used in the worksheet series follows the system adopted for New Zealand conditions described in the Land Use Capability Survey Handbook (Soil Conservation and Rivers Control Council, 1971).

The classification has three components — a class, a subclass and a unit. The diagram below illustrates the relationship between the various components of the land use capability classification:



Assumptions

In assessing land use capability, a good to above-average level of management is assumed.

For land where permanent irrigation has been installed, the classification is made on the basis that the soil moisture limitation has been permanently removed.

Where permanent drainage has been installed or appears to be a reasonable proposition, the classification is made on the basis of the degree of limitation existing or likely to exist after drainage.

Capability classification

The capability class is the broadest grouping of the capability classification. It is an assessment of how versatile the land is for sustained production taking into account its physical limitations. It gives the general degree of limitation to use.

There are eight classes represented by roman numerals. Classes I-IV are suitable for cropping, pasture or forestry while Classes V-VII are limited to pastoral or forestry use. The limitations reach a maximum with Class VIII land which is not suitable for grazing or production forestry; it best serves a protection function.

The capability subclass is identified by a lower case letter in the land use capability code. It divides the land within each class according to the major kind of limitation to use. There are four kinds identified but only the dominant one for each land unit is recorded.

The four subclasses are:

e erodibility — where susceptibility to erosion is the dominant limitation to use

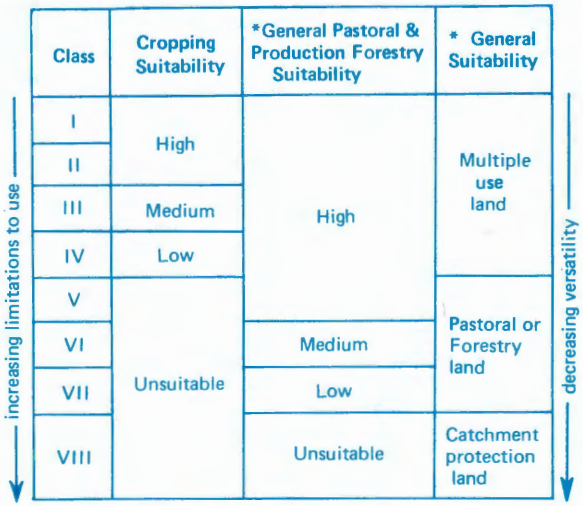
w wetness — where a high water table, slow internal drainage, and/or flooding constitutes the major limitation to use

s soil limitation — where the major restriction to use is a limitation within the rooting zone. This can be due to a shallow soil profile, stoniness, rock outcrops, low soil moisture holding capacity, low fertility (where this is difficult to correct), salinity or toxicity

c climate — where the climate is the major limitation to use.

In the land use capability code, the capability unit is represented by an arabic number. It groups together land inventory units which require the same kind of management and the same kind and intensity of conservation treatment. Units of land having the same land use capability unit number are capable of growing the same kind of crops, pasture or forest species and have about the same potential yield.

The capability units are arranged in order of decreasing versatility of use and increasing degree of limitation to use, so that, for example, VIIe5 has a higher use capability than VIIe8 but not as high as VIIe2.



* land use capability classes IV — VII which have wetness as the major limitation and those units in very low rainfall areas or those occurring on shallow soils are normally not suited to production forestry.

Illustrated description of capability classes





National Publicity Studios



National Publicity Studios

Class I

This is the most versatile multiple-use land with virtually no limitations to arable use. It is highly suitable for the growing of a wide range of cultivated crops, pasture or forests.

It is flat, or nearly flat, land with deep, easily worked soils. These are usually well supplied with plant nutrients and are responsive to applied fertilisers. The climate is favourable for the growth of a wide range of plants and there is little risk of erosion.

Class I land is confined almost entirely to small areas of well-drained soils derived from alluvium, located mostly on the former flood plains of the larger rivers. It occurs throughout New Zealand but is very limited in total area.



National Publicity Studios



National Publicity Studios



National Publicity Studios



National Publicity Studios



National Publicity Studios

Class II

This is very good land with slight limitations to arable use which can be readily overcome by management and conservation practices. The land may be used for cultivated crops, pasture or forestry.

Most Class II land is flat or undulating with the most common limitations being wetness, slight textural problems, or shallow soils.

Class II land is more widespread and abundant in New Zealand than Class I land. Soils are derived mainly from alluvium, although some in the North Island have developed on fine-textured volcanic ash.



National Publicity Studios



National Publicity Studios



National Publicity Studios

Class III

This class of land has moderate limitations to arable use which restrict the choice of crops able to be grown and/or make special conservation practices necessary. It may be used for cultivated crops, pasture or forestry.

Class III land is widely distributed throughout New Zealand. It commonly occurs on undulating to rolling country which has a moderate erosion risk when cultivated, on shallow and stony soils of plains and terraces, and in narrow river valleys where runoff from adjacent hills gives rise to wetness limitations.



International Harvester Company



National Publicity Studios



National Publicity Studios





National Publicity Studios

Class IV

This land has severe limitations to arable use. These limitations substantially reduce the range of crops which can be grown and/or make intensive conservation treatment and careful management necessary. In general, Class IV land is suited only to occasional cropping, but is well suited to pastoral and forestry use.

The most common limitations to use are erosion, shallow, stony and/or low fertility soils, excessive wetness and other effects of climate such as those associated with altitude.

Class IV land is widely distributed throughout New Zealand commonly occurring on undulating to strongly rolling country. It occurs in similar situations as Class III land but the limitations are more pronounced and are therefore more restrictive to cropping.

Class V

This is high producing land which has limitations which make it unsuitable for cropping but which has only slight limitations to pastoral or, in general, forestry use.

The most common limitations which preclude arable use are slope, the presence of boulders and rock outcrops, or excessive wetness. Erosion is not a dominant limitation in this class as the land is relatively stable under a permanent vegetative cover.

Class V land is limited in its occurrence in New Zealand. It is generally confined to very stable hill country and localised areas of river flats.









National Publicity Studios





Lindberg Photography Ltd

Class VI

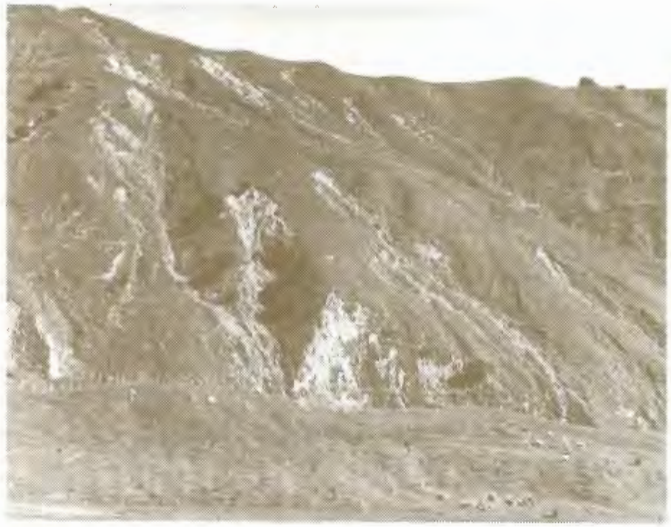
This is non-arable land which has moderate limitations and hazards under a perennial vegetation cover.

Erosion is commonly the dominant limitation on Class VI land. However, it can be minimised by appropriate soil conservation measures. Soil limitations also commonly restrict use but wetness and climatic factors are less dominant limitations.

Class VI encompasses most of New Zealand's good, relatively stable, hill country, but can include stony and shallow soils of fans and terraces.







Class VII

This land is unsuitable for arable use and has severe limitations or hazards under a perennial vegetation. With few exceptions it can only support extensive grazing or erosion control forestry.

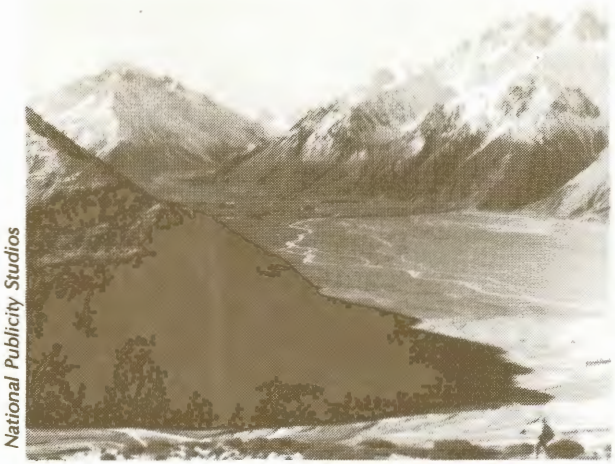
The limitations to use of Class VII land are similar to those affecting Class VI land but are intensified. Risk of erosion is frequently the dominant limitation making careful conservation management for grazing use necessary. Class VII land can also have severe soil, wetness or climatic limitations.

Land of Class VII is widely distributed and includes much of the steeper and more erodible North Island hill country as well as South Island 'high country'. It also occurs, although to a lesser extent, on the shallow, stony and/or low fertility soils of the fans and terraces (including 'pakihi' land).





National Publicity Studios



National Publicity Studios





Class VIII

This land has very severe to extreme limitations or hazards which make it unsuitable for arable, pastoral, or production forestry use. Soil conservation and water management are the main on-site and off-site concerns in the use of this land. It is suitable for catchment protection purposes, which include water management interests, and also for recreational uses.

The most common limitation to use is extreme actual or potential erosion. This may be combined with severe climatic limitations.

Class VIII land is mainly high, mountainous country although it may include very steep slopes and also highly erodible areas at lower altitudes, such as fore dunes.



National Publicity Studios

Illustrated description of capability subclasses

The land use capability subclass shows the major kind of limitation to use of each land use capability class.

The dominant limitation or hazard determines which of the subclasses 'e', 'w', 's', or 'c' is used. In practice there are often several limitations affecting the one land unit at the same time. Where two or more kinds of limitations are essentially equal, the subclasses are given the following priority for recording: 'e', 'w', 's', 'c'. That is, 'e' is given precedence over 'w', 's' and 'c', and 'w' is given precedence over 's' and 'c' and so on.

Subclasses are applied to all capability classes although subclass 'e' (erodibility) does not occur as the dominant limitation on Class I or Class V land. The following apply:

Class	Subclasses applicable
I	w, s, c
II	e, w, s, c
III	e, w, s, c
IV	e, w, s, c
V	w, s, c
VI	e, w, s, c
VII	e, w, s, c
VIII	e, w, s, c



erosion – 'e'



wetness – 'w'



soil limitation in rooting zone – 's'



climate – 'c'

Illustrated description of capability unit

The concept of the land use capability unit is often the most difficult to grasp. To illustrate the relationship between the unit, subclass and class, a series of photographs of the Poverty Bay area is shown.

In each case, the class and subclass remain unchanged, but the unit number is different indicating that each unit, while having the same broad degree of limitation (Class VII) and the same dominant kind of limitation (subclass 'e'), differs in the conservation and management techniques required to sustain production or differs in the type of crops able to be grown or also in potential yield.



VIIe 13 – moderately steep hills of erodible argillites and shales.



VIIe 18 – steep hills of argillite with serious gully erosion.



VIIe 4 – moderately steep to steep hills of argillite.



VIIe 16 – steep to very steep, seriously slipping mudstone hill country.



VIIe 20 – strongly rolling hills of bentonitic mudstone with serious earthflow erosion.

Ways to apply the land resource information

Computer and manual alternatives

Requests for land resource information come from boards, councils, foresters, agriculturalists, economists, engineers, planners, teachers and so on — in short, from many and varied sources.

These requests are usually for information about specific areas of land such as catchments or counties, or about land within a certain distance of a port, city or town.

In meeting these requests the inventory factors may be used either singly or in combination and the land use capability assessment may be used by itself at the class, subclass or unit level or in combination with inventory factors.

The two examples which follow represent closely similar questions, one of which has been answered via the computer-aided data storage and retrieval system operated by the Water and Soil Division — the other shows how the answers can be obtained manually by the user.

Example 1 (computer-assisted)

For 'X' county a planner may wish to know the physical capability of the county for certain types of development options, the types of land management that may be necessary to develop the land, and the feasilibity of this being realised. The answers to the following questions asked of the computer would assist the planner in gaining this information.

- How much land has a moderate to high capability for long term sustained production? Where is it located?
- How much land is mainly pasture-covered?
- How much land has a medium to high pastoral potential and is at present:
  (a) mainly scrub-covered?
  (b) mainly covered with native forest?
- How much land is physically suited to productive afforestation?
- How much land, excluding that with a medium to high pastoral or cropping potential, should undergo erosion control afforestation?
- How much productive land is at present subject to serious erosion under a pastoral vegetation cover?

At this stage the role of the land resource scientists at the Data Facility is to convert the questions to the terminology of the inventory and capability codes on the worksheets. Examples of these codes which correspond, in order, to the questions the county planner wished to know are:

- List and locate, giving areas, all units of land in Classes I - VI.
- List and locate, giving areas, all units with capital 'P' as the dominant vegetation symbol.
- List and locate all units of land in Classes I - VI with:
  (a) capital 'M' as the dominant vegetation symbol;
  (b) capital 'N' as the dominant vegetation symbol.
- List and locate all units of land in Classes I-VI excluding IIIw, IVw, Vw and VIw.
- List and locate VIIe land with an erosion degree of 3 or greater.
- List and locate all units of land in Classes I - VII with 'P' as the dominant vegetation symbol and an erosion degree of 3 (severe) or greater.

Details of the area (in hectares) and location (both as grid references and as four colour computer-plotted transparent overlays) of land can be supplied by the computer to satisfy the factors specified in the questions by the user.

This is what the answers to the questions would look like. In each case, the answer is given in three sets of two columns — the left hand column gives the grid reference and the right hand column gives the area of land in hectares.

Table A* — (this table lists all units of land in Classes I - VI):

821286	276	836003	50	097268	477
093031	98	841297	54	084017	49
839290	183	032265	138	899255	288
962181	214	875007	575	247096	22

Total = 2424 ha

Table I* — (this table gives units with capital 'P' as the dominant vegetation symbol)

083135	370	059219	79	047159	145
108091	315	103236	221	047199	463
058072	178	082182	131	070242	314
052121	172	079155	209	033136	94

Total = 2691 ha

Table AG* — (this table gives units in Classes I - VI with 'M' as the dominant vegetation symbol)

821286	276	836003	50	875007	575
962181	214	032265	138	097268	477

Total = 1730 ha

Table AH* — (this table gives units in Classes I - VI with 'N' as the dominant vegetation symbol)

841297	54	839290	183	899255	288
093031	98	084017	49	247096	22

Total = 494 ha

Table BC* — (this table gives units in Classes I - VI excluding IIIw, IVw, Vw VIw)

806003	70	812015	592	810096	2168
858247	445	831245	280	899255	288
886238	66	871226	1000	844015	327
928233	125	906237	1017	915245	253
014215	445	034244	280	998263	288
030012	282	990019	710	061270	1347
058072	131	069060	445	054057	213
218296	27	213292	54	225296	56
234197	388	206190	287	183183	393

Total = 11977 ha

Table D* — (this table gives VIIe land with an erosion degree of 3 or greater)

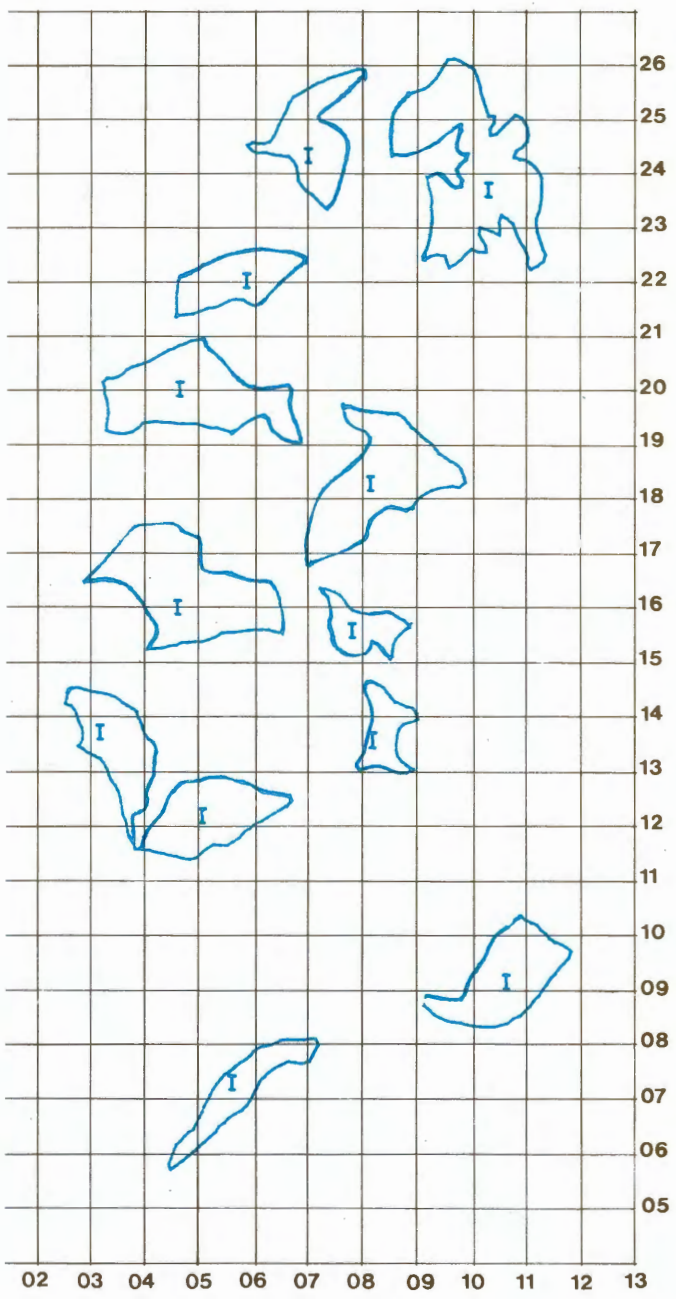
806003	70	812015	592	825186	4251
809237	214	801236	20	976266	186
966220	270	994231	1180	007242	415
082182	314	099178	133	118181	175
119219	2163	099193	467	173112	528

Total = 10978 ha

Table EFI* — (this table gives all units of land in Classes I - VII with 'P' as the dominant vegetation symbol and an erosion degree of 3 (severe) or greater).

Total = 0 ha

This information can also be presented as a computer-plotted overlay which shows the spatial distribution of the units. In this example, Table I is plotted — that is, all units with capital 'P' as the dominant vegetation symbol are drawn. The scale of the plot has been reduced to 1:126,720 (one inch to two miles).



* This is a computer code only and bears no relation to any particular question or symbol.

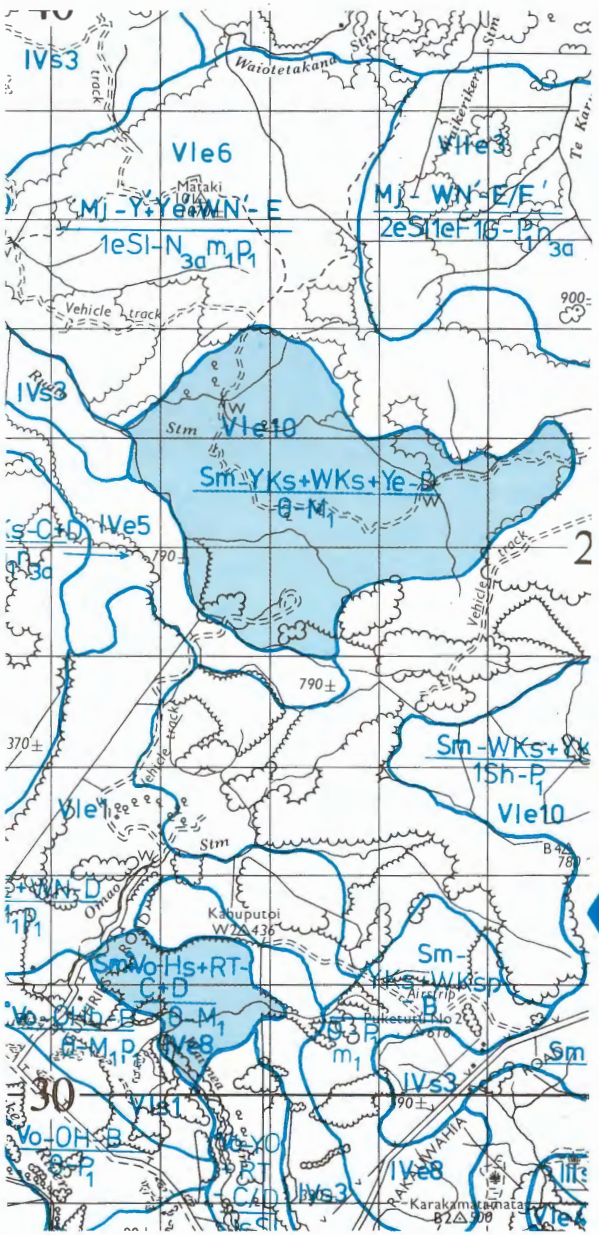
Example 2 (manual)

A farm advisor may wish to advise on the economics of developing easy sloping, scrub-covered sandstone country.

First of all he must know the extent and location of this type of country.

Procedure: From the North Island work-sheet legend it can be seen that:

- "sandstone" corresponds with:
  Sm (Sandstone-massive)
  Sb (Sandstone-banded)
- "easy sloping" land corresponds with:
  C slopes (8° - 15° — rolling)
  D slopes (16° - 20° — strongly rolling)
- "scrub" corresponds with:
  M as the first recorded vegetation symbol.



To identify these areas refer to the rock type, slope and vegetation sections of the inventory formula:

$$\frac{\text{Rock type} — \text{Soil unit} — \text{Slope}}{\text{Erosion} — \text{Vegetation}}$$

and locate all those inventory units which have codes with either Sm or Sb as the first recorded (that is, dominant) rock type, as well as C and/or D as the first recorded slope grouping, and also M as the first recorded vegetation symbol.

These units can then be coloured or marked in some way on the worksheets.

The option of computer-assisted or manual retrieval of information holds for all examples that now follow, although only the manual version is shown.

Inventory applications

Information given in the inventory codes can be used in different ways to answer specific questions.

Single factor

Any one inventory factor may be extracted for use on its own to answer a specific question relating to that physical factor.

Example 3

A forest logger may wish to know which land can be traversed by wheeled vehicles. Such land coincides with flat to rolling slopes.

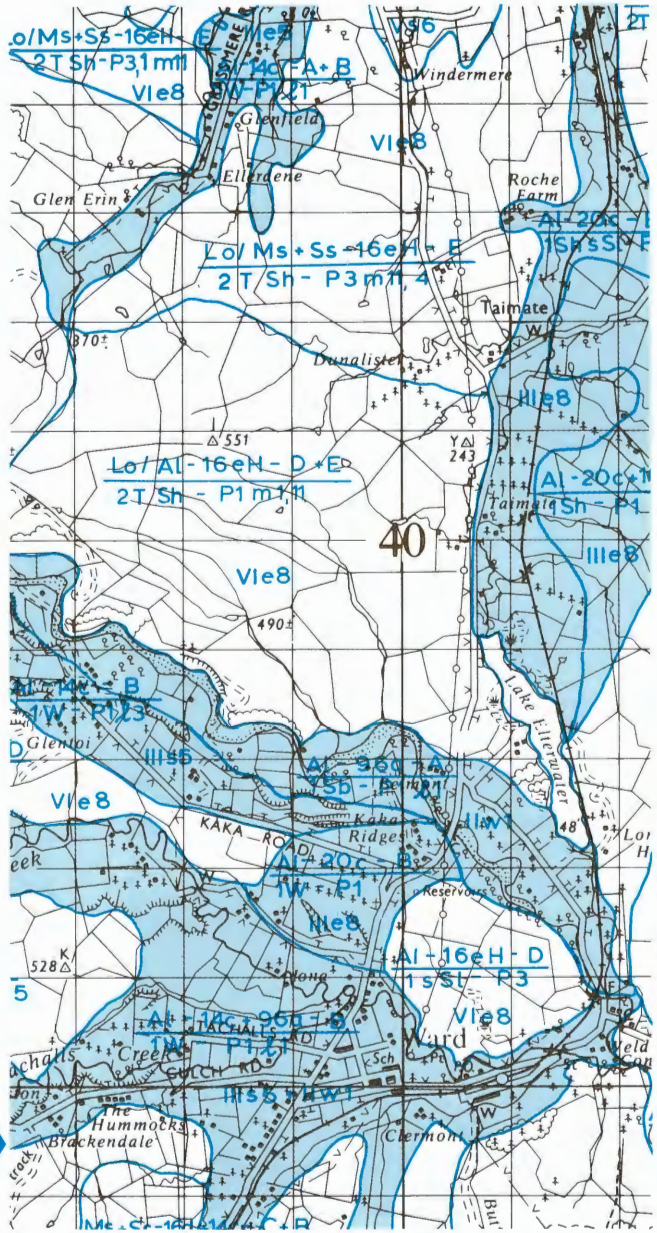
Procedure:
From the worksheet legend it can be seen that flat to rolling slopes include:

A slopes (< 3° — flat to gently undulating)
B slopes (4° - 7° — undulating)
C slopes (8° - 15° — rolling)

To identify these areas go to the slope section of the inventory formula:

$$\frac{\text{Rock type — Soil unit — Slope}}{\text{Erosion — Vegetation}}$$

and locate all those inventory units which have A, B, or C as the dominant slope group (that is, where any one of these is the first recorded slope group).





J. H. G. Johns (New Zealand Forest Service)

Example 4

A noxious weeds inspector may wish to show where the main areas of gorse are located in his area.

Procedure:

From the worksheet legend:

M8 = gorse (dominant cover)
m8 = gorse (subdominant cover)

So to identify these areas go to the vegetation section of the inventory formula:

$$\frac{\text{Rock type — Soil unit — Slope}}{\text{Erosion — Vegetation}}$$

and locate all those inventory units in which the vegetation is either M8 or m8.



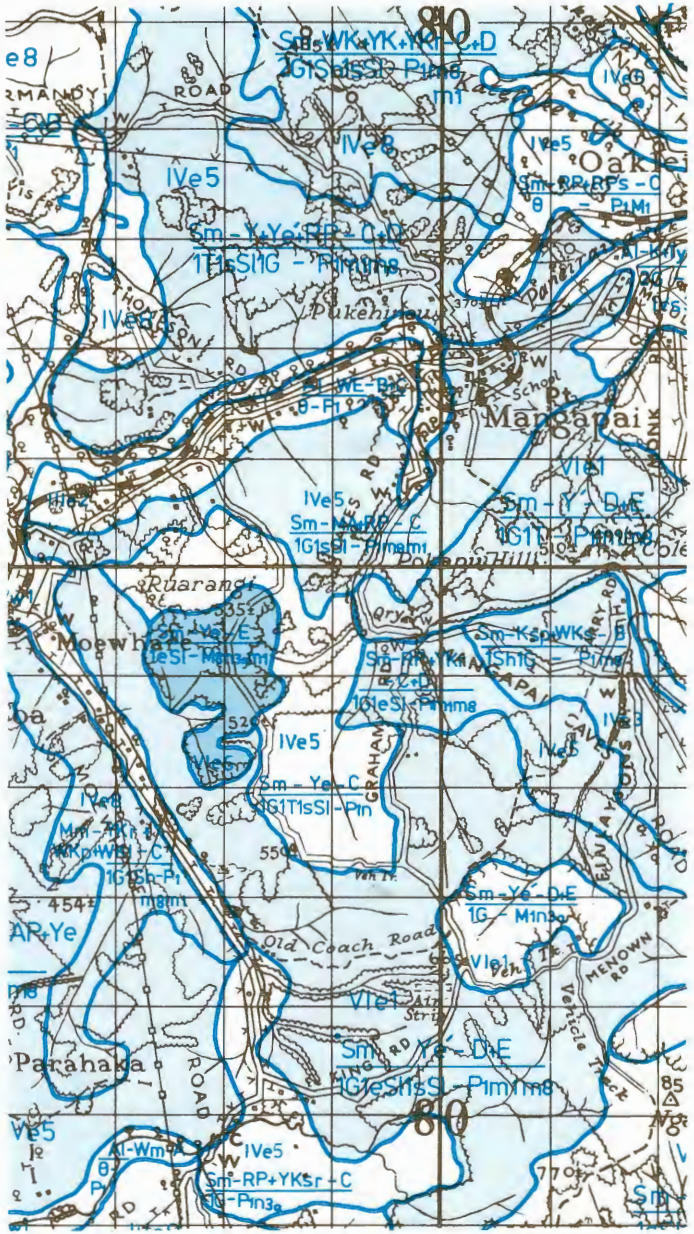
KEY:

Gorse as dominant vegetation cover.

Gorse as subdominant vegetation cover.



R. D. Clarke



Example 5

A power board planning a new power reticulation line through an area of volcanic deposits needs to know, for excavation purposes, which are areas of hard volcanic rocks, and which are areas of soft volcanic rocks or ash.

Procedure:

By using the appropriate worksheet legend and extended legend, the two types of volcanic rocks can be identified. In this case hard volcanics correspond to Vo, and soft volcanics or ash to Tp, Ft, Lp, Kt and Mo.

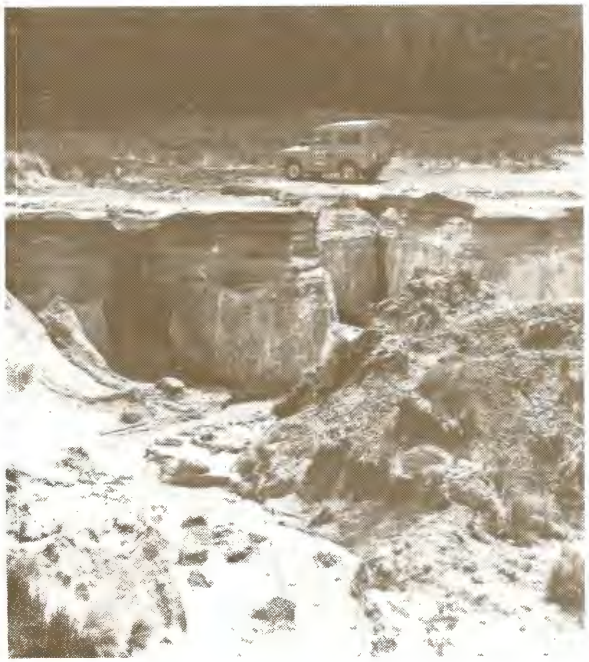
To identify these areas, go to the rock type section of the inventory formula:

$$\frac{\text{Rock type} — \text{Soil unit} — \text{Slope}}{\text{Erosion} — \text{Vegetation}}$$

and locate all inventory units which have hard volcanics as the dominant rock type (that is, Vo recorded first) and those which have dominantly soft ash cover (that is, one or more of Tp, Ft, Lp, Kt and Mo recorded first). These two types of volcanics (hard and soft) can then be coloured differentially on the worksheet.

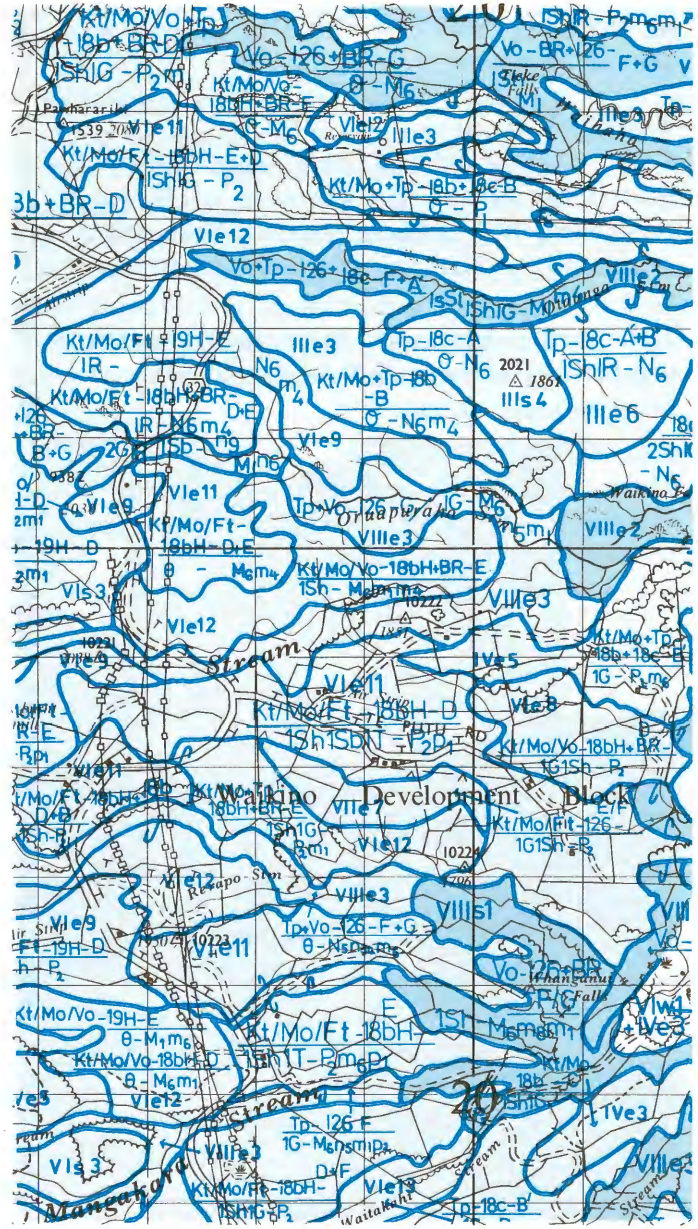
KEY: *Hard volcanics.*

Soft ash cover.





Soft, easily excavated volcanic ash (left); hard, stable volcanic rock (above).



Multi-factor

Two or more of the inventory factors may be extracted and combined to answer a specific question.

Example 6

Catchment board staff may wish to show board members the amount of high-producing hill country pasture land that requires intensive soil conservation measures.

This coincides with land with high-producing pasture on hilly slopes which has severe present erosion.

Procedure:

The worksheet legend shows that severe erosion corresponds with the following severity ratings:

3 — severe
4 — very severe

Hilly slopes correspond to:

D slopes —(16°-20° strongly rolling)
E slopes — (21°-25° moderately steep)
F slopes — (26°-35° steep)

High-producing pasture corresponds to:

P1

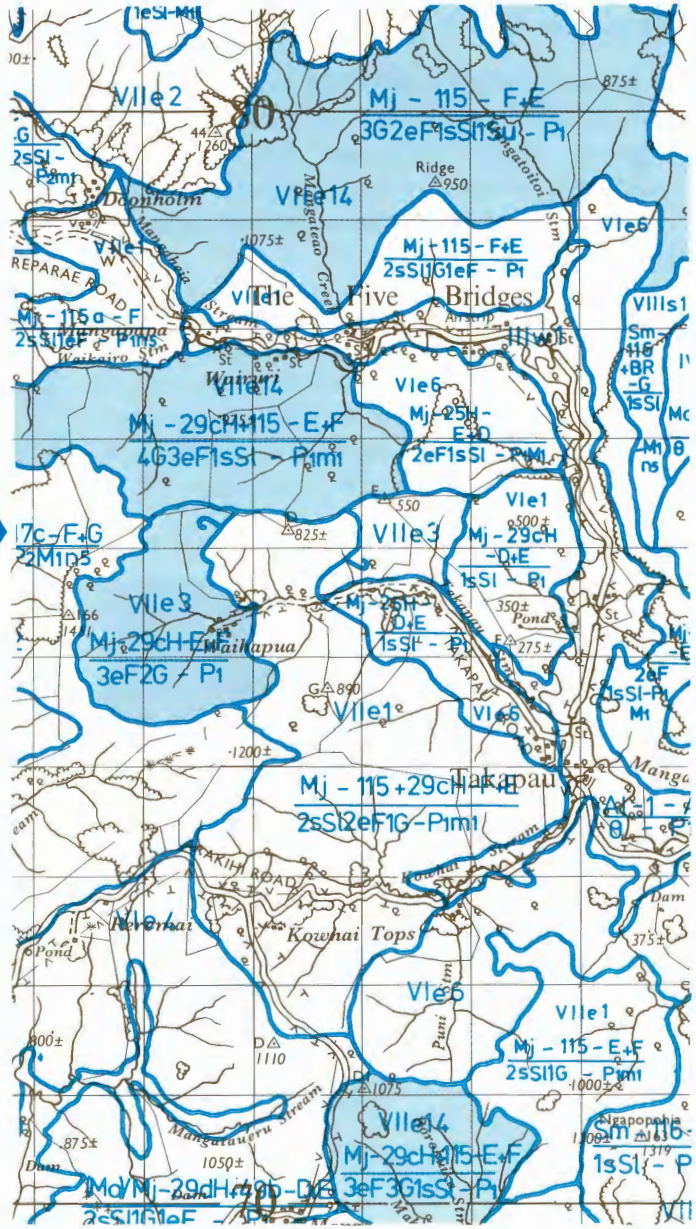
Identifying these areas entails going to the slope, erosion and vegetation sections of the inventory code:

$$\frac{\text{Rock type — Soil unit — Slope}}{\text{Erosion — Vegetation}}$$

and locating all inventory units which have either 3 or 4 as the degree of erosion, and at the same time, have D, E or F as the slope and a capital P1 as the first recorded vegetation symbol.



M. J. Crozier (Victoria University of Wellington)



Example 7

A landscape architect may wish to identify areas of landscape interest which are worth protecting, adjacent to a highway.



National Publicity Studios

These could be identified on the worksheets as areas of native forest on steep to very steep slopes.

Procedure:
The worksheet legend shows that steep to very steep slopes correspond to:

F slopes — (26°-35° steep)
G slopes — (>35° very steep)

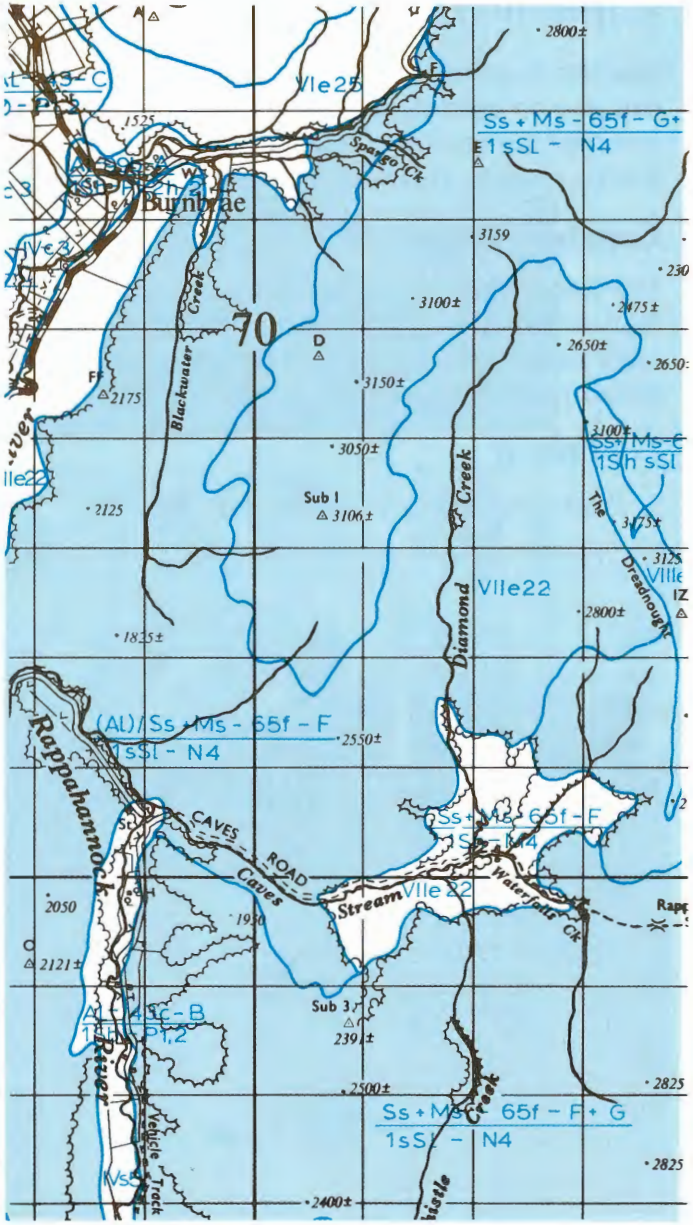
Native forest corresponds to:

N1 — coastal forest
N2 — kauri forest
N3 — podocarp/hardwood forest
(a) lowland; (b) mid-altitude.
N4 — beech forest
(a) lowland; (b) highland.
N5 — hardwood forest
N7 — podocarp forest

Identifying these areas entails going to the slope and vegetation sections of the inventory code:

$$\frac{\text{Rock type} — \text{Soil unit} — \text{Slope}}{\text{Erosion} — \text{Vegetation}}$$

and locating all units which have either F or G as the first recorded slope grouping, as well as any one of N1, N2, N3, N4, N5, or N7 as the first recorded vegetation symbol.



Capability applications

Like the inventory code the capability code can also be used to give answers to specific questions. It can be used at any of the three levels — class, subclass, or unit.

Capability class

The interpretation of land resource information provided by the land use capability class provides a useful tool for answering broad planning questions.

Example 8

A food processing company may wish to know where all the prime arable land, and arable land of a somewhat lower potential, is located, with a view to expansion of business interests.

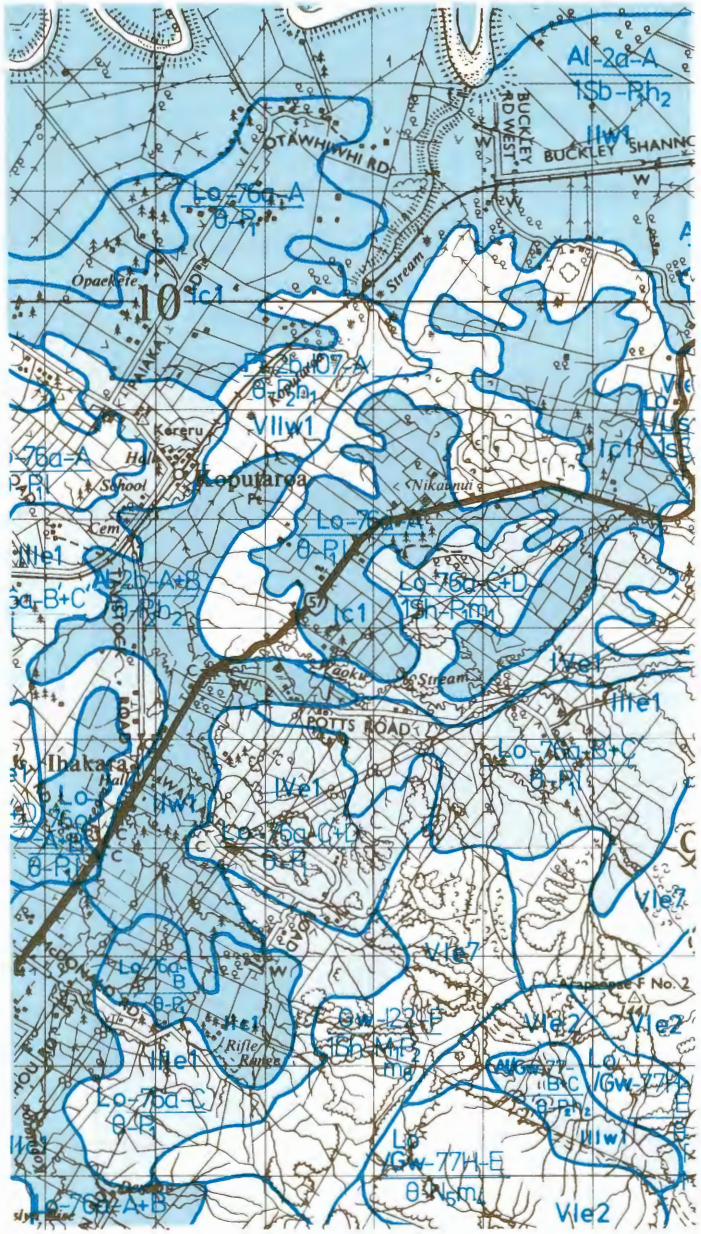
Procedure:
Answering this question involves selection of the appropriate land use capability classes:

I, II } Prime arable land

III, IV } Other arable land

and then the location of all land inventory units which possess these land use capabilities.





Capability subclass

The subclass level of the land use capability classification identifies the dominant kind of limitation:

e — erosion
w — wetness
s — soil limitation within the rooting zone
c — climate

The subclass may be used by itself to indicate a particular kind of limitation, but will more often be used in combination with the capability class to give a degree and kind of limitation.

For instance, subclass 'w' indicates that the dominant limitation to use is excessive wetness. By using the capability class together with the subclass 'w', the degree of this limitation can be identified, giving an indication of the difficulty of drainage.

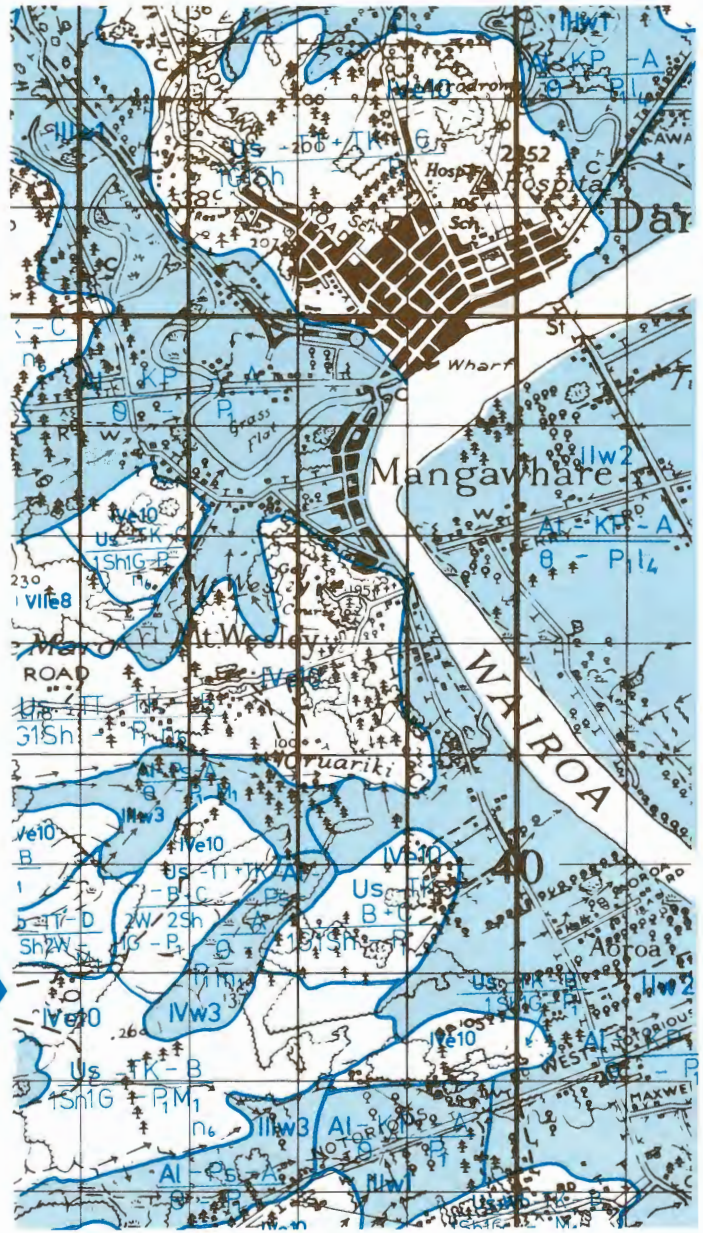
Example 9

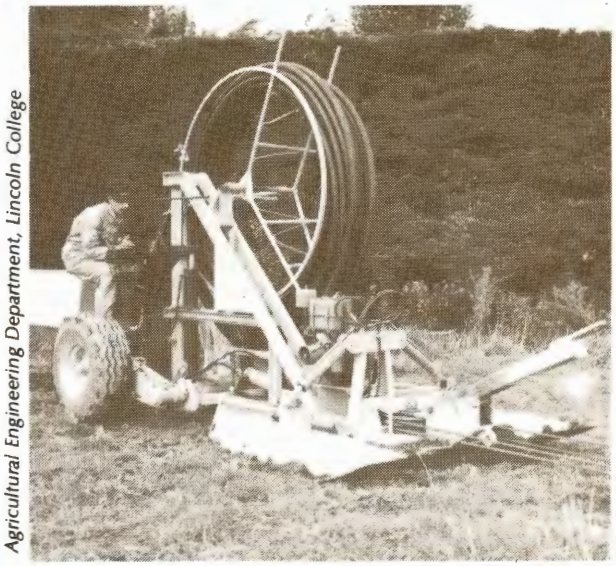
A drainage contractor may wish to know where all the arable land is on which production would be enhanced by drainage.

Procedure:

Locate all the land inventory units which are arable (land use capability Class I, II, III or IV) but which have a wetness limitation (subclass 'w'); that is, Iw, IIw, IIIwand IVw.

Since the degree of limitation increases from Class I to Class IV, wetness will be imposing a very much greater constraint on production in the case of IVw land than on Iw land.





Agricultural Engineering Department, Lincoln College



Agricultural Engineering Department, Lincoln College

Example 10

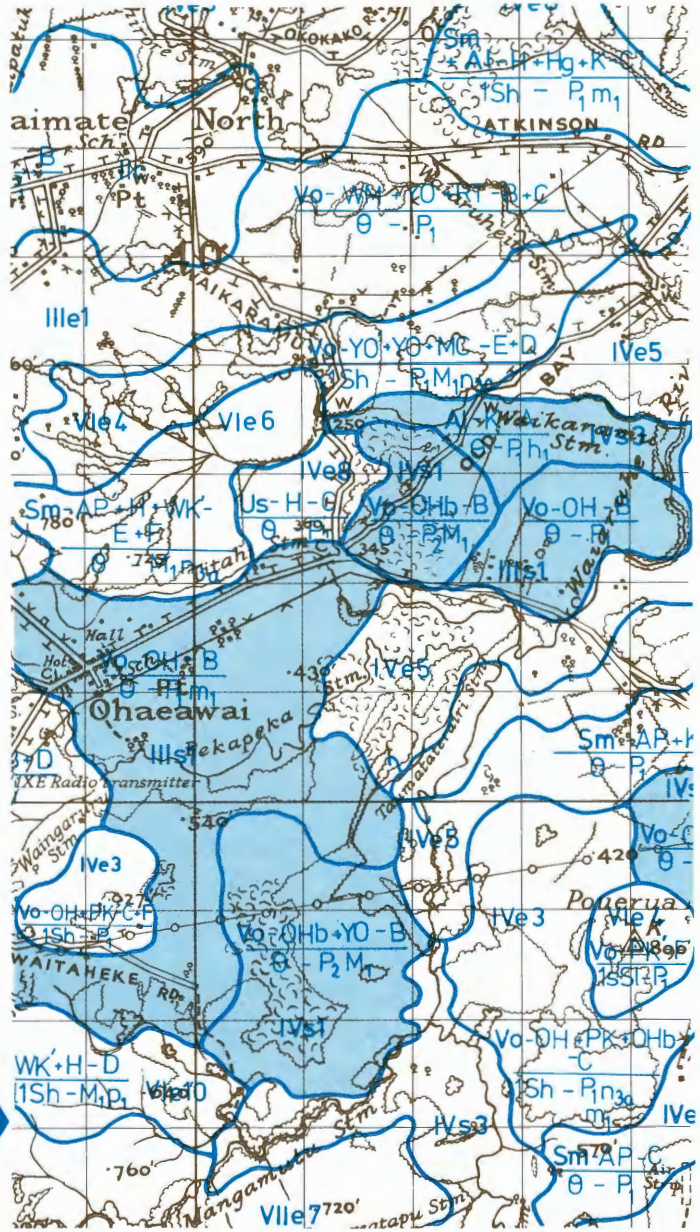
A farm machinery manufacturer may wish to know which areas of potentially arable land have stones and boulders that need to be removed by machinery.

Procedure:

Identify all arable land (Classes I-IV) which has the subclass 's' — that is, a soil limitation within the rooting zone. In this example, the 's' limitation must refer to the presence of stones and boulders, so check in the extended legend to see that this is the case and that the subclass 's' does not refer to some other limitation in the rooting zone such as shallowness of soil.

Although the selection of arable land involves Classes I-IV, Classes I and II are excluded in this example since by definition they can have only very slight to slight limitations. Any stones or boulders that may occur would create only a minor limitation and would not justify the use of machinery for their removal.

Therefore, defining areas of potentially arable land with stones and boulders that need to be removed by machinery involves locating all IIIs and IVs land which has stones and boulders as its particular type of 's' limitation.





G. G. Lindsay (Agricultural Engineering Department, Lincoln College)



Capability unit

The capability unit is the most detailed level of the land use capability classification. It divides the land within each subclass of each class into management categories.

Therefore the land use capability unit can be used to answer more specific types of planning questions.

Example 11

A county planning consultant may wish to locate categories of land which need to be protected by forest vegetation for stability reasons. Of these areas, he also may need to know those that can be used for production forestry and those that need to be retained in forest solely for protection purposes.

Procedure:

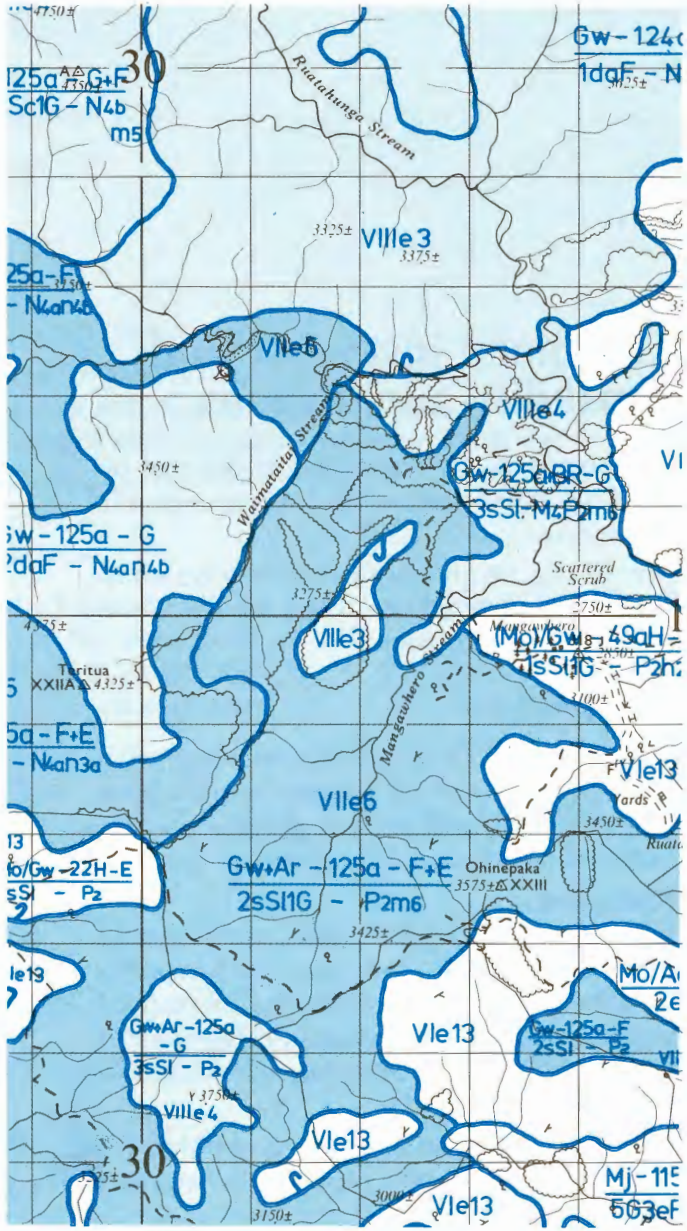
The extended legend should be consulted to find the various units which fit these criteria. On the type of land in question, the subclass will be 'e' because of the erosion hazard. Only on VIIe and VIIIe land will the erosion hazard be so great that afforestation is necessary to reduce erosion levels. Other classes are therefore excluded.

By consulting the extended legend, those VIIe units suitable for erosion control forestry, and VIIIe units which are suitable only for protection forestry, can be located.

KEY:

Suitable for erosion control forestry.

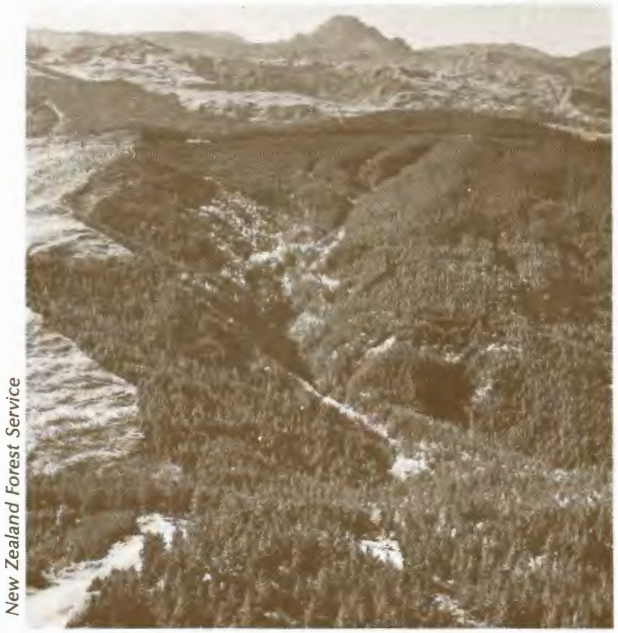
Suitable only for protection forestry.





New Zealand Forest Service

Protection planting on Class VIII land.



New Zealand Forest Service

An afforested Class VII catchment.





P. Morrison (New Zealand Wildlife Service)

Combined inventory and capability applications

The inventory and capability codes can be used in combination to answer specific questions.

Any of the inventory factors may be combined with any of the three levels of the capability classification.

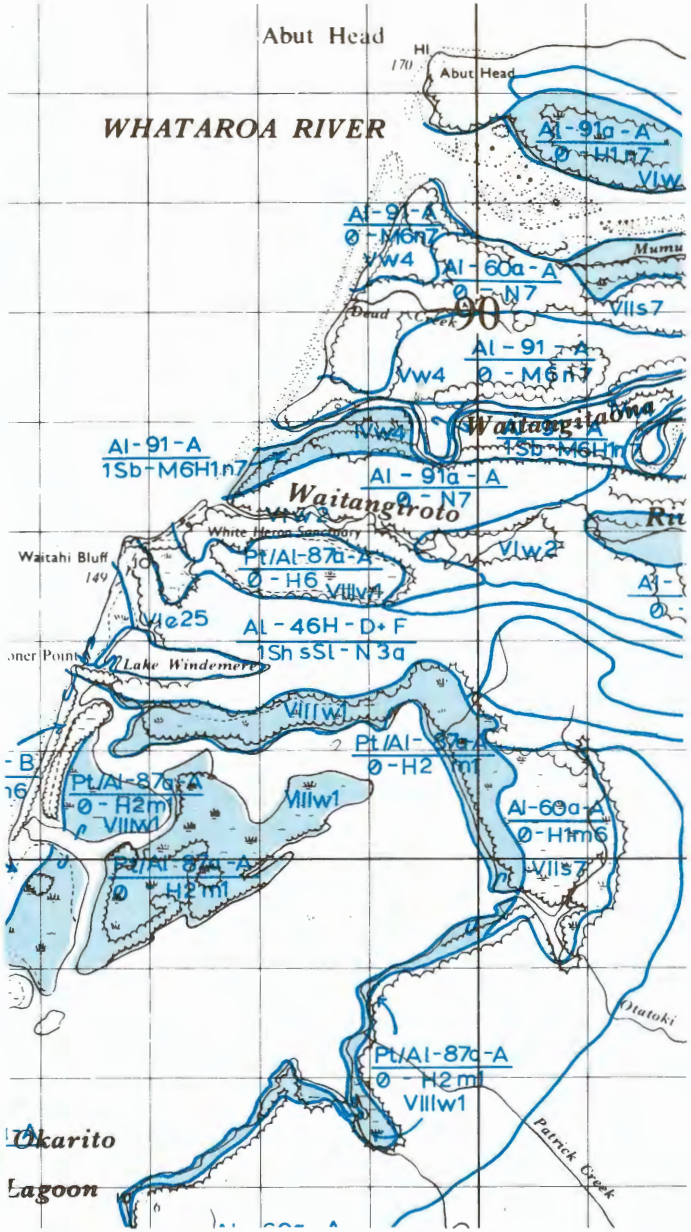
Example 12

A wildlife or environmental group may wish to identify areas of swamp associations where rushes and sedges require protection as a particular kind of wildlife habitat.

Procedure:

Examine all capability units surrounding water bodies and select those with capability subclass 'w'. Next, from the worksheet legend, select the vegetation categories of swamp associations of rushes and sedges — H1 and H2.

Those units with subclass 'w' and either H1 or H2 can then be coloured or marked accordingly.



Where to apply the land resource information

Worksheet information can be used at a range of different levels of planning for different objectives. The main reasons why the worksheets show this flexibility are that:

- the inventory presents basic, unclassified information which can be used in a variety of ways for different purposes by a wide range of users
- the land use capability assessment is based on the permanent physical features of the land and therefore does not change when vegetation and land use change
- the information is produced at a consistent national standard which enables comparisons to be made between regions within the country using a common language of land description
- the worksheets have been produced over a relatively short period of time; periodic revision will keep them up to date and enable the monitoring of major land use changes
- their scale makes it possible to identify broadly the physical land characteristics before detailed land use planning begins
- they provide a base on which other factors important in land use planning can be superimposed
- the technique is well suited to easy computer storage of information and retrieval in computer printout or 'map' form.

Land use planning at different levels

The worksheets may be used at four distinct planning levels — national, regional, district and large catchment. Their versatility allows any of the three levels of the land use capability classification to be used (class, subclass or unit) depending on the degree of refinement required, and the specific planning objectives.





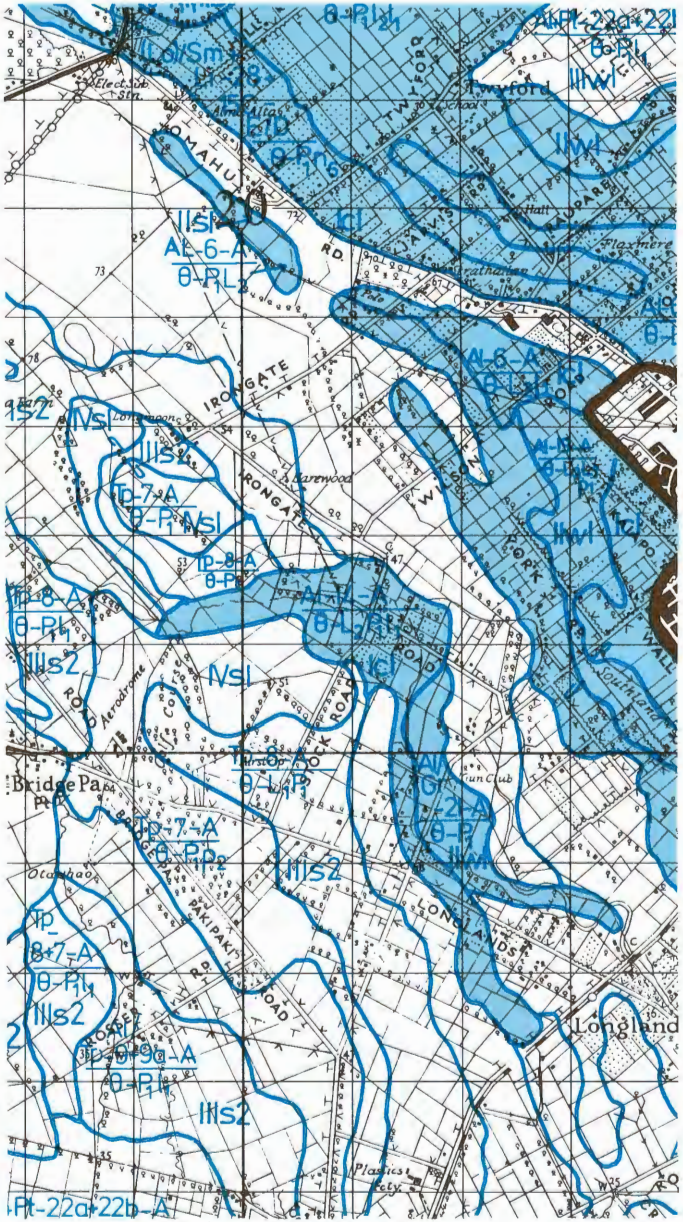
National planning

Worksheets provide a physical base for establishing, for example, national targets for agricultural and forestry production. This is done by attaching potential productivity values to each land use capability class, subclass or unit, depending on the degree of detail required. Inventory factors can be used to refine these categories further. The computerised sorting, tabulation and area calculations are a great advantage in handling resource information on a national scale.

Example 13

Government may wish to identify areas of "land having high actual or potential value for the production of food" (Town and Country Planning Act 1977) which should be protected for productive purposes. These are areas of land belonging to either Class I or Class II.







International Harvester Company

Regional planning

The worksheets are especially useful in the preparation of regional planning schemes.

The extended legend gives an assessment of potential land uses, information which is particularly useful to the planner who may be determining future land uses.

If relative potentials are known, the suitability of areas of land for specific activities or combinations of activities can be assessed in physical terms. This then provides a basis on which to consider community-oriented social, economic, environmental and aesthetic factors.

At the regional level land use capability classes are used as a base from which to derive policy areas for planning. This has been done in the Hamilton Regional Planning Scheme, where land use capability is being used to help identify the range of uses which are most suitable for particular areas of land. For instance, Class I land coincides with the Agricultural Protection Policy Area of the scheme. Classes II-IV coincide with a General Farming Policy Area, Classes VI-VII with a Hill Country Conservation Policy Area, and Class VIII with an Environmental Protection Policy Area.

HAMILTON REGIONAL PLANNING SCHEME: POLICY AREAS

POLICY AREA	LAND USE CAPABILITY CLASS	AGRICULTURAL PRODUCTION	URBAN DEVELOPMENT	FORESTRY	ENVIRONMENT CONSERVATION	PRIORITY FOR ACTION
1 Agricultural Protection	I	Preserve versatility and potential for intensive production.	Prohibit unless exceptional circumstances.	No	Protect high soil productivity.	High
2 General Farming	II, III, IV	Conserve as arable farmlands which are suitable for dairy production and crop cultivation.	Allow only under carefully controlled conditions.	No	Conservation supervision important.	Medium
3 Hill Country Conservation	VI, VII	Conserve for pastoral farming and afforestation.	Discourage	Yes (commercial)	Conservation supervision very important.	Medium
4 Environmental Protection	VIII	No productive uses.	Prohibit	Yes (protective)	Conservation supervision essential.	Medium
5 Mineral Resources	Any except I	Restore wherever possible.	Control very carefully	No	General supervision very important.	High
6 Landscape Interest	Mostly VI, VII	Carefully control farming/forestry	Discourage strongly	Possibly	Environmental control especially significant.	Low
7 Regional Recreation	Various	Conserve until public acquisition	Prohibit	Possibly	Conservation and general environmental supervision important.	Medium
8 Future Urban Development	Mostly II, III, IV	Conserve until urban need	Staged and structural	No	Encourage good management.	High

(Hamilton Regional Planning Authority, 1976)

Such policy areas guide local territorial authorities when establishing rural zones and ordinances in district planning schemes.

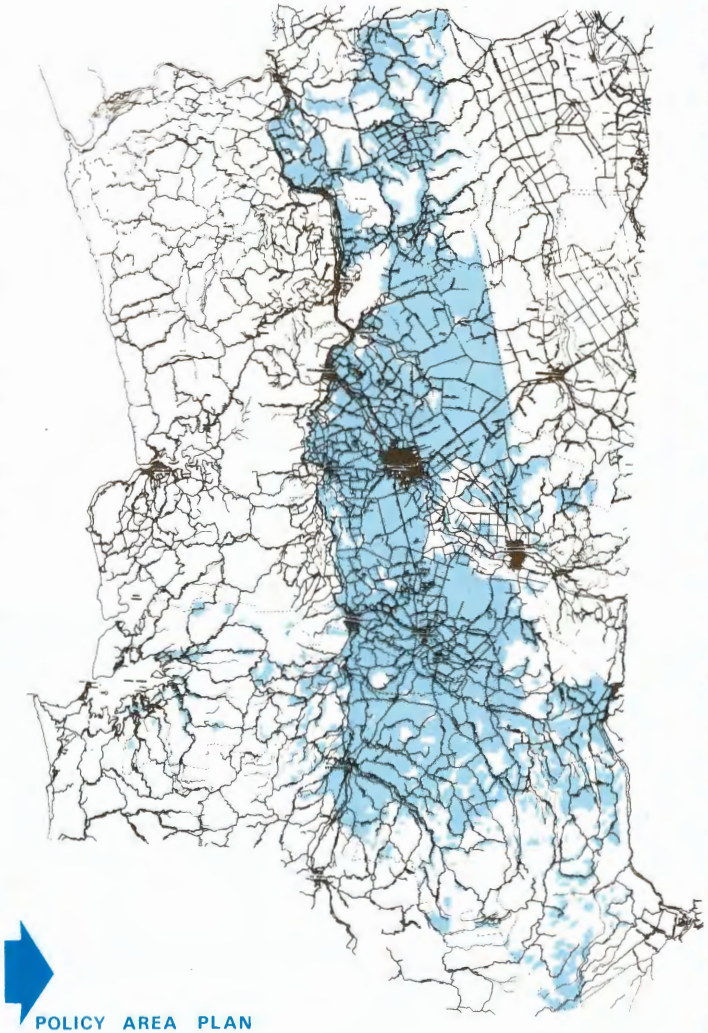
For these purposes, the capability system indicates where the range of uses might need to be limited.

For example:

- land belonging to Class I is of high agricultural value and should be protected from urban encroachment
- land in Classes II-IV requires few safeguards
- Class VII land may be used for grazing or forestry with appropriate conservation measures, but if it is to undergo sustained use, or any change of use, it is recommended that professional advice be obtained from a local catchment authority
- Class VIII land is not suitable for primary production (that is, productive cropping, grazing or forestry) due to the nature and severity of its limitations or hazards.

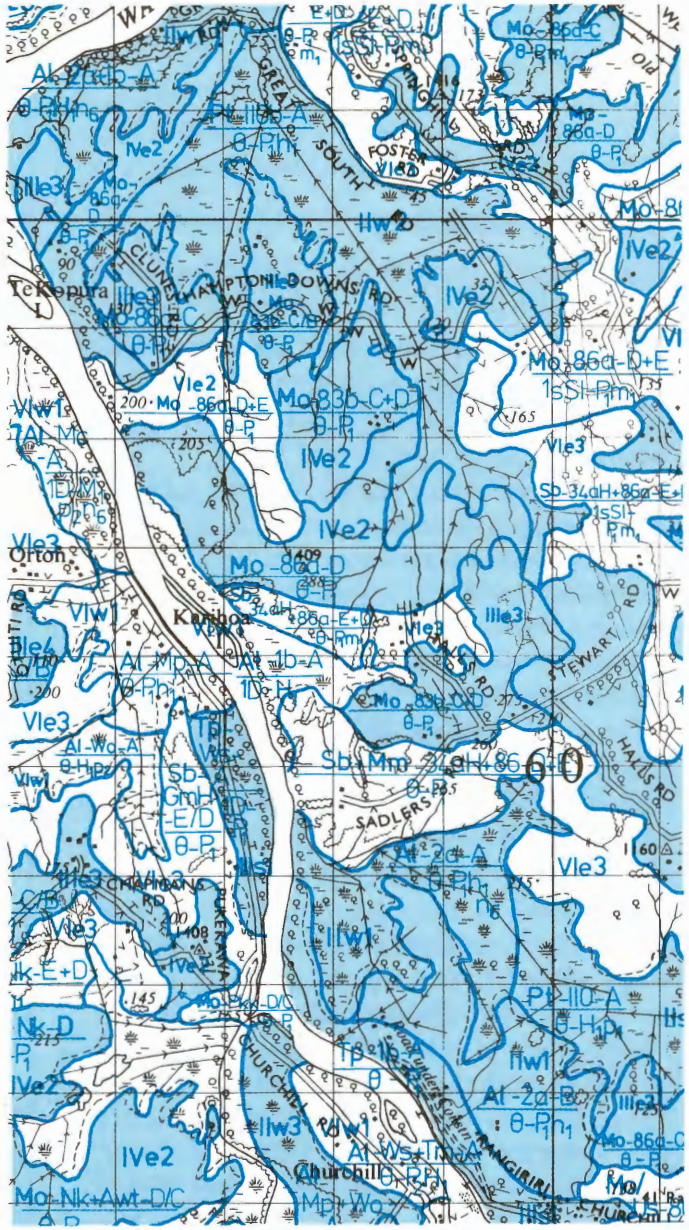
Example 14

The map on the immediate right (at a scale of approximately 1 inch to 16 miles) shows the General Farming Policy Area delineated in the Hamilton Regional Planning Scheme. From the table on the preceding page it can be seen that these areas correspond to land use capability classes II, III and IV. On the far right is a worksheet (at the scale of 1 inch to 1 mile) of part of the Hamilton Region with the equivalent areas shaded.



POLICY AREA PLAN

GENERAL FARMING AREAS



District planning

Using the worksheets as a base, local authorities can easily identify areas where development may be safely promoted or should be restricted. For example, areas can be defined which should be protected from urban intrusion and preserved for intensive forms of agriculture, and areas most appropriate for production forestry, for semi-rural living or for mineral extraction can be identified.

At the district scheme level of planning the 1:63,360 scale worksheets will usually need detailed backup information when conditional use, specified departure or subdivisions and building applications are involved. For instance, at the boundary of an urban area, where highly productive soils are frequently involved, detailed soils information should complement the worksheets.

In any detailed use of the worksheets, limitations of the 1:63,360 scale should be kept in mind. To prevent possible misusage, the best method is to consult the local catchment authority which is able to provide specific interpretation and advice.



The land use capability system has proved to be very useful in various statutory planning processes because it uses simple and familiar terms for land description which can be used consistently throughout the country.

Example 15

For a district scheme review, a county councillor may wish to identify areas where the land is subject to severe to extreme earthflow erosion, as this has caused problems for both highways and rural dwellings. These areas can be identified in the district scheme where, for example, engineers' certificates must be obtained before a dwelling may be erected.

Procedure:

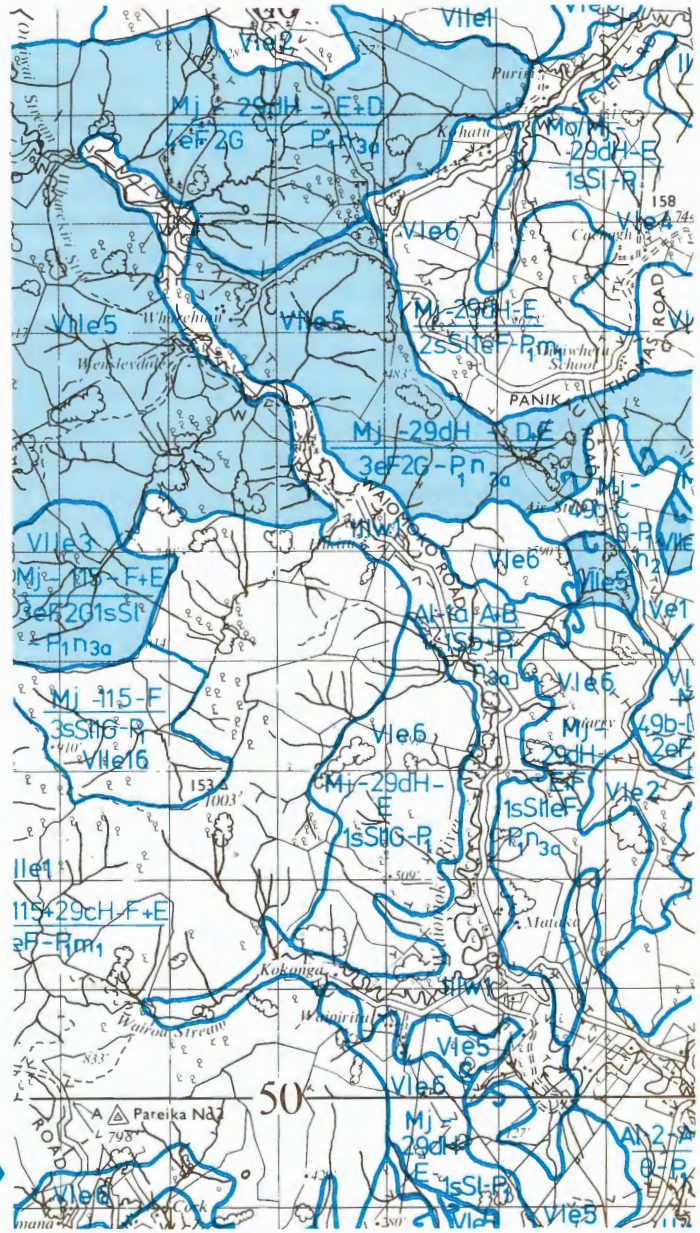
From the worksheet legend it can be seen that earthflow erosion corresponds to 'eF' and that severe to extreme erosion corresponds to the following severity ratings:

3 — severe
4 — very severe
5 — extreme

Identifying these areas entails going to the erosion section of the inventory code:

$$\frac{\text{Rock type — Soil unit — Slope}}{\text{Erosion — Vegetation}}$$

and locating all inventory units which have either 3eF, 4eF, or 5eF as the erosion degree and type.

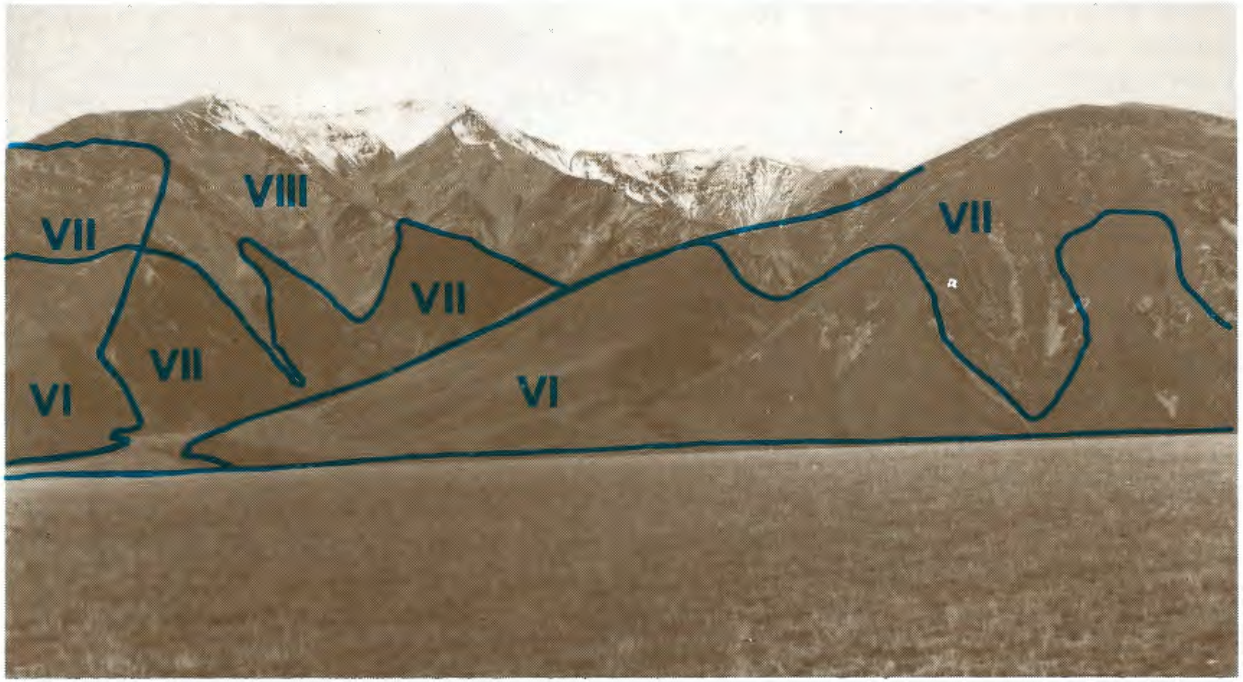


Catchment or mountain range planning

Worksheets are well suited for use in broad planning in large catchments in a manner similar to their use in regional and district scheme planning. Complementary planning is done by catchment authorities who carry out more detailed inventory and capability surveys where there are specific requirements for detailed planning for design and costing of works, or for remedial treatment. These surveys are normally at scales between 1:20,000 and 1:30,000 and are of catchment areas up to 20,000 ha.

One of the most important uses of the worksheets in catchment planning is in identifying areas of high erosion risk. Soil conservation measures listed in the extended legends provide generalised advice on techniques required to control existing erosion or prevent potential erosion. Such techniques may, for example, involve the displacement of livestock. It follows therefore that the worksheet information can provide a basis for broad consideration of the economic effects and the extent of measures that would be necessary to increase carrying capacity. The worksheets also provide information on the location and extent of better classes of land that are capable of being improved further.

Worksheets may also be used for initial broad assessment of irrigation potential. This information is obtained from the land use capability unit description in the extended legends with reference, where necessary, to inventory factors.



Example 16

Worksheets have been used to define soil conservation and water management zones over land in Classes VI, VII and VIII on an entire mountain range. Suitability for grazing is broken down into four categories which show a gradation from land that is suited to grazing under specified conditions, through to alpine barren land unsuitable for any form of grazing use. Boundaries of inventory units show where fence lines may be required to separate land management zones. The areas of the units may be used for estimating requirements such as for oversowing and topdressing.

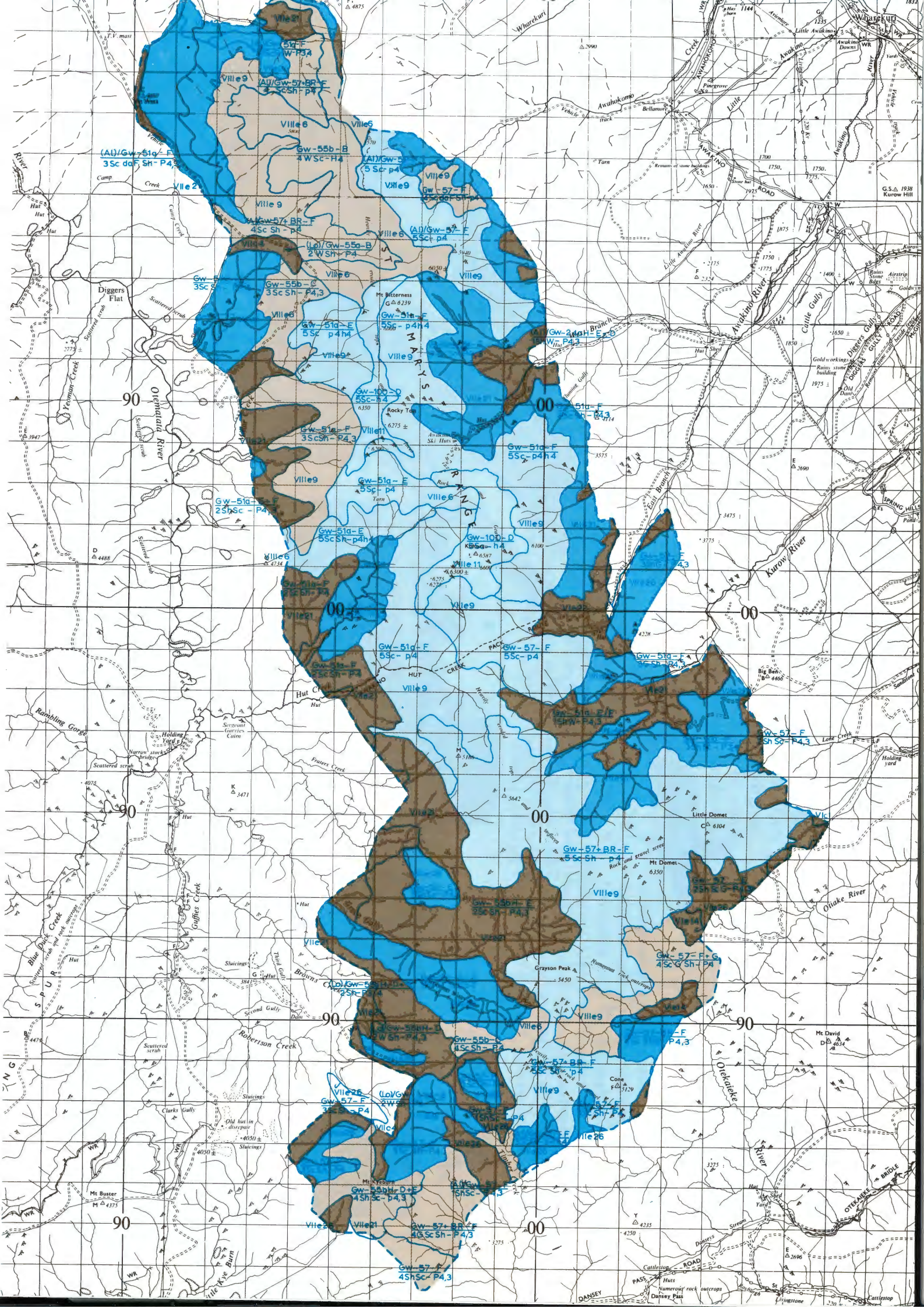
KEY:

Land suitable for permit grazing.

Severely eroded land requiring strict control of permit grazing.

Extremely eroded land requiring destocking and retirement from grazing.

Alpine barren land which is unsuitable for any form of grazing use.


Whurekuri
Awakino
Awakino Downs
Awakino River
Little Awakino River
Awakino Ski Hut
Awakino Ski Hut
Bellamore
Pinegrove
Diggers Flat
Mt Bitterness
Rocky Top
Mt Domet
Little Domet
Grayson Peak
Mt David
Mt Buster
Cone
Big Ben
Otiake River
Otiake
Otiake River
Otiake
Otiake
Otiake

Land use planning for different purposes

The suitability of land for different purposes can be established from the information on potential land use that is listed in the extended legend.

Agriculture

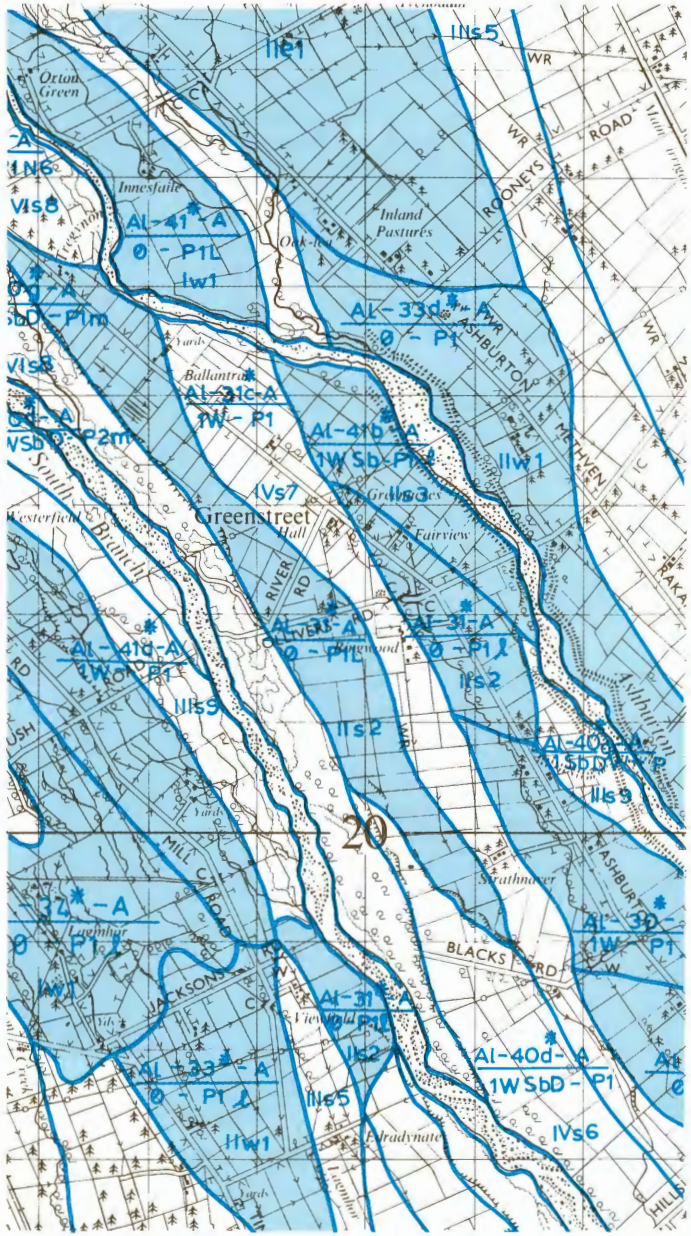
The worksheet information can be used to show opportunities for development or production potentials. In the extended legends, statements and indices of agricultural potential have been arrived at through consultation between staff of the Water and Soil Division acting for NWASCO, the Ministry of Agriculture and Fisheries, and the Department of Lands and Survey.

The suitability of land for agricultural production may be assessed according to four categories. These constitute only a broad guide to the use of the worksheets in agricultural planning. Further subdivision of these groups is recommended where more detailed levels of planning are required.

The categories are:

a good multiple-use land with few limitations to use **(Example 17)** — this is land which has few constraints for either arable or pastoral development and productivity. It includes all Class I and II land.





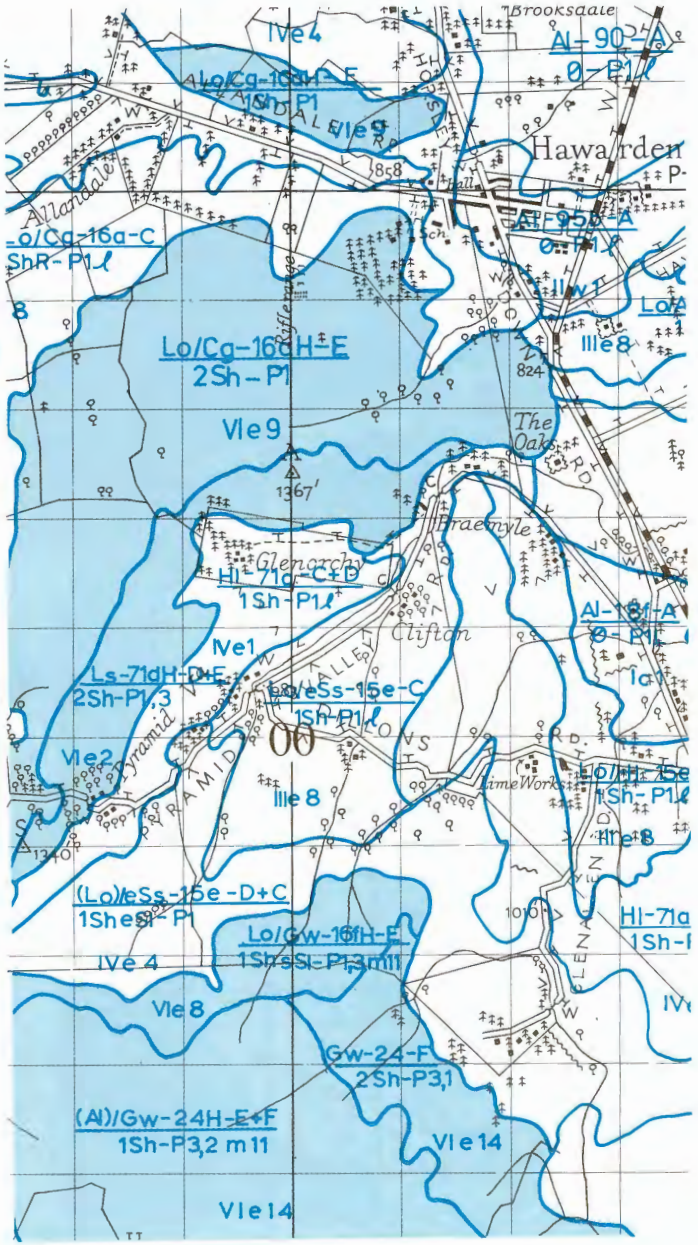
b land on which agricultural activity can be safely concentrated but where there are some limitations to use. This includes land that has limitations that range from negligible to severe with respect to arable development and productivity (Classes I - IV) and negligible to moderate with respect to pastoral development and productivity (Classes I - VI).

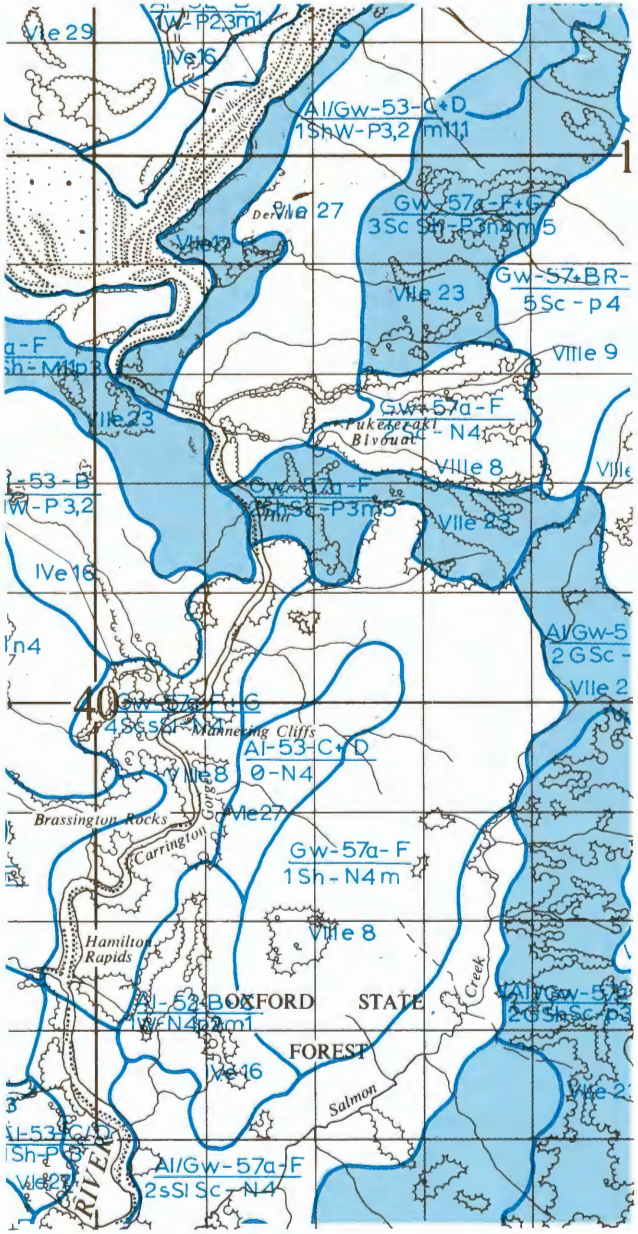
Example 18

Pastoral farming can be safely concentrated on non-arable land that has a negligible to moderate erosion risk. This applies to VIe land where the use of good development practices and soil conservation measures can easily contain the erosion risk.



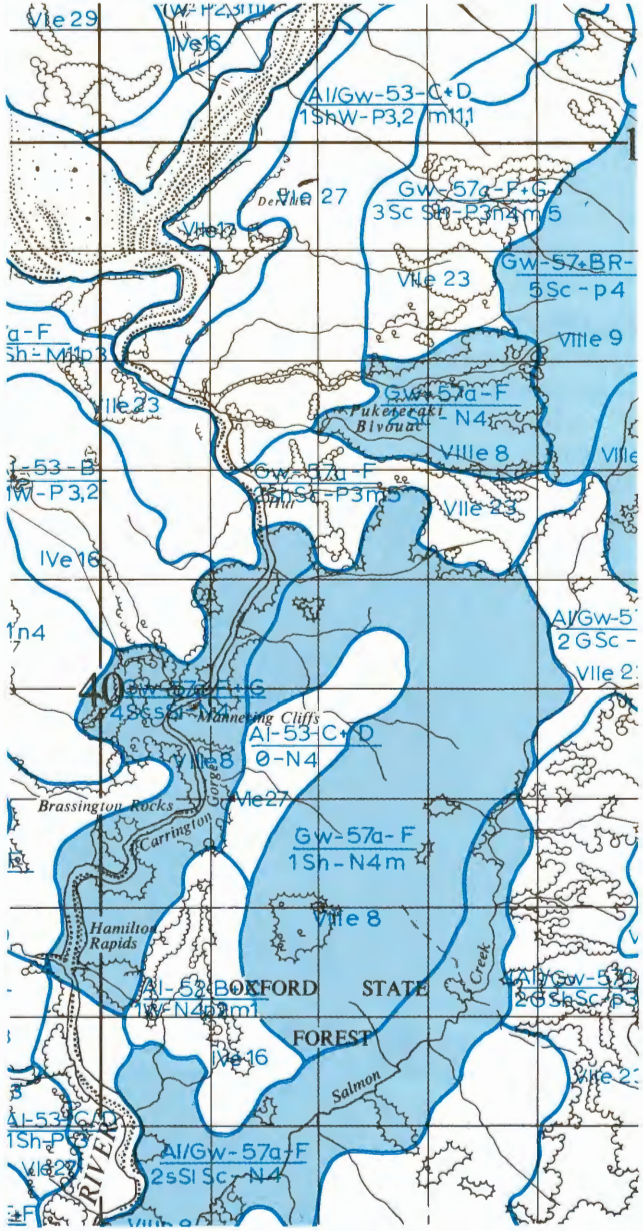
National Publicity Studios





c land which has substantial constraints on agricultural land use such as a severe erosion risk or very poor drainage. This applies to Class VII land (**Example 19**). (The most eroded units of Class VII, while physically capable of use with severe limitations, are, on a recommended use basis, frequently managed as Class VIII land, especially where downstream catchment effects have to be considered.)

d land which is physically unsuitable for agriculture as it has extreme limitations to use. These may be too high an erosion risk to permit development, extreme shallowness or absence of soil, very severe climate, or extreme wetness. This applies to all Class VIII land (**Example 20**).



Forestry

Worksheets provide information which is useful for both regional and/or more localised forestry planning. As with agriculture, the extended legends provide statements and indices of forestry potential that have been arrived at through consultation between staff of the Water and Soil Division acting for NWASCO, and the New Zealand Forest Service.

Worksheets can be used at the regional level to provide physical information for the preparation of regional development plans which show the potential of the land for forestry. Physical information for forestry planning which can be obtained from the worksheets includes the location and extent of different types of land and particularly whether it is in a developed or undeveloped state, or whether it suffers from excessive wetness.

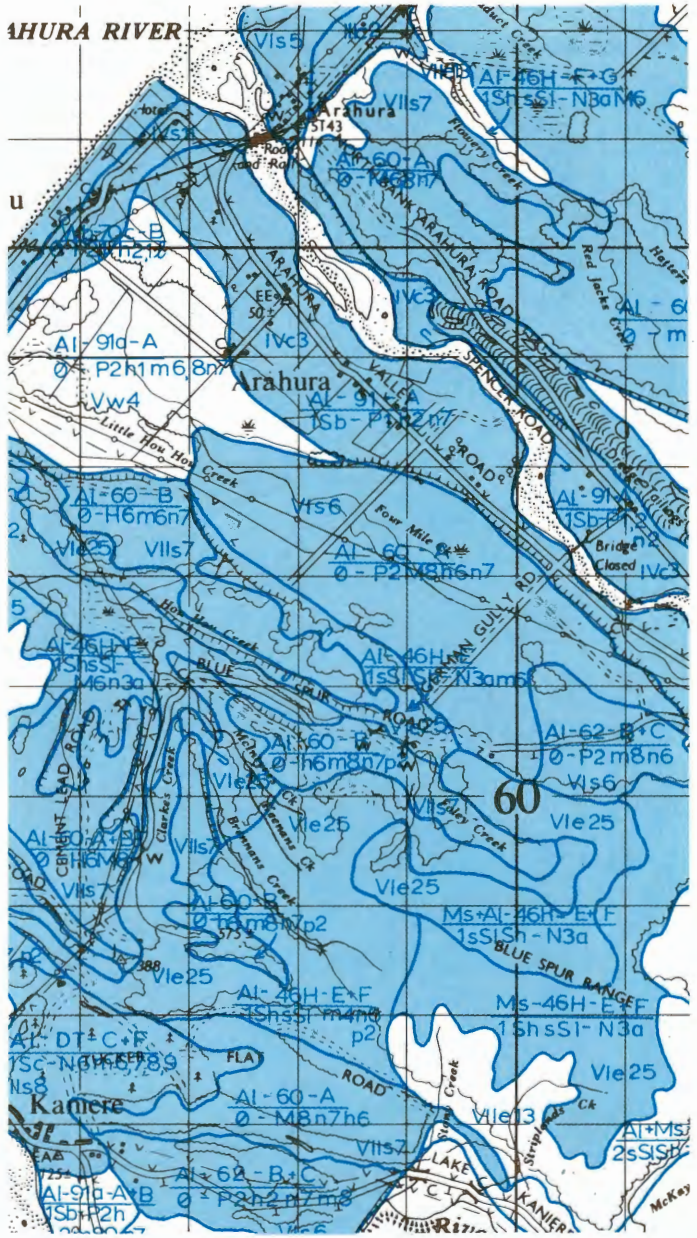
The land's physical suitability for forestry can be assessed by interpreting the land use capability information, the inventory information, or a combination of the two. This information is then tied to other indices used by foresters to assess production potentials.

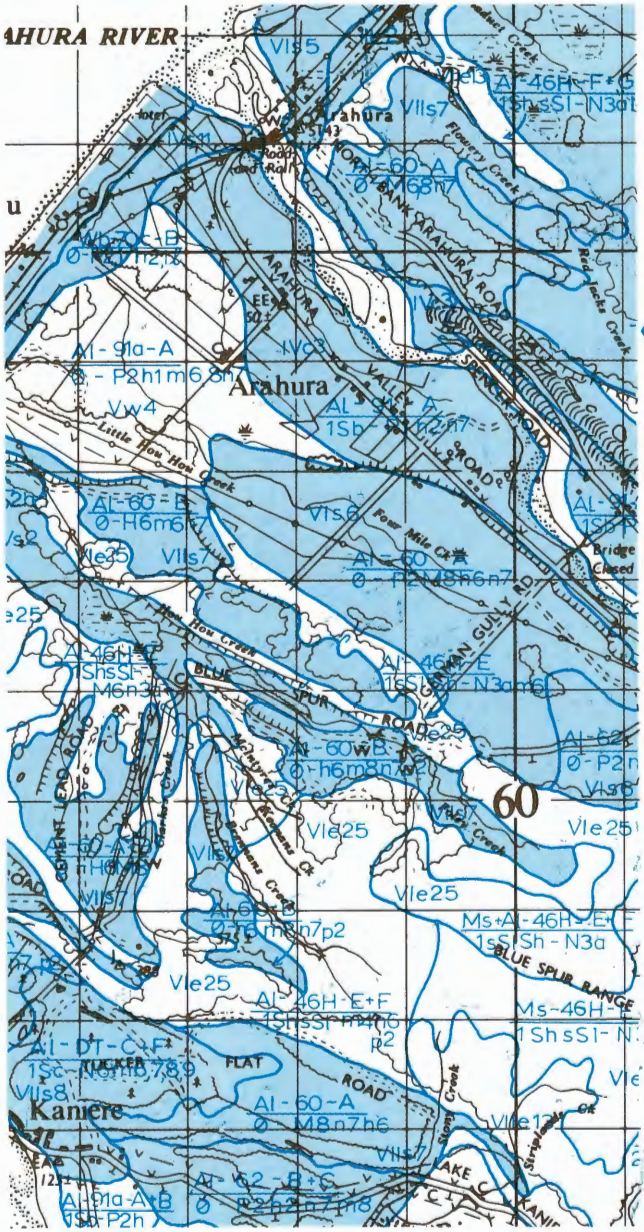


National Publicity Studios

Example 21

All capability units potentially suitable for the establishment of production forestry have been shaded. These have been selected from the extended legend that would accompany this worksheet.





The physical factors shown in the inventory formula are important for their influence on forestry management activities.

Example 22

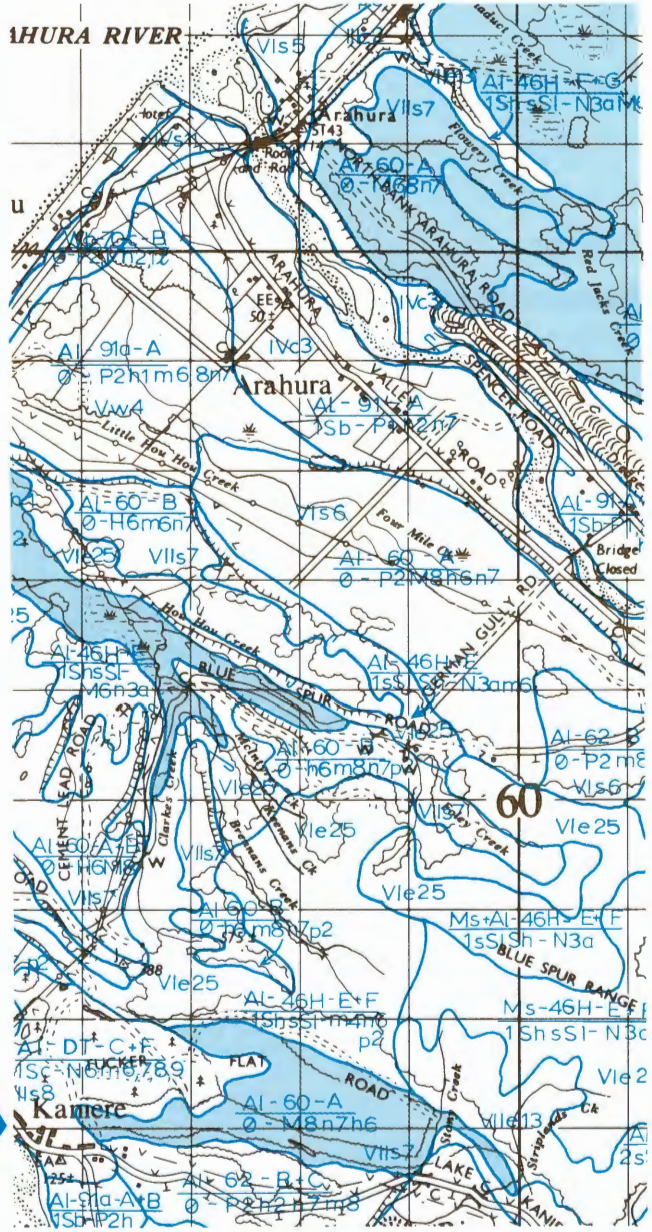
Slope determines what logging techniques can be used as it affects the use of wheeled vehicles.

Capability units suitable for production forestry where wheeled vehicles can be used for harvesting are shaded. As this example uses the same area as shown in Example 21, the same capability units are suitable for production forestry. However, in this example areas where wheeled vehicles can be used for harvesting must also be known. This occurs on slopes that are less than 15 degrees (that is, A, B, or C slopes). Therefore, only those units shaded in Example 21 which also have A, B or C slopes are shaded in Example 22.

Example 23

Vegetation affects the economics of forest establishment and, with slope, determines the techniques used to clear the land (for example, burning, cutting, cultivation or gravity rollers). The vegetation classification in the inventory has been designed to assist such management considerations.

Shaded are capability units suitable for production forestry (as in Example 21), where slopes are again less than 15 degrees (as in Example 22), on scrub-covered slopes ('M' or 'm' as the first recorded vegetation type in the inventory code.



Forests perform two main functions, production and protection, the relative significance of each depending on the erodibility of the land.

Three categories of land suitability for production forestry can be identified:

a land which has high or moderate physical suitability for production forestry — included is all land in Classes I-VI except land with severe wetness, very low rainfall or shallow soil limitations. Production potentials can then be shown by relating site indices to the land use capability units;

b land which imposes substantial physical constraints on production forestry — this is dominantly Class VII land where the constraints consist of various combinations of erosion, wetness, soil and climatic limitations. For instance, an erosion risk necessitates careful management and the use of soil conservation measures. Soil limitations can impose difficulties on forestry development and/or substantially reduce growth rates. Wet areas are generally avoided. Similarly, areas with climatic extremes such as low or excessive rainfall, areas subject to frost, or short growing seasons which occur at the higher altitudes, are avoided. These are all factors which limit production afforestation;

c land physically unsuitable for production forestry — this includes all Class VIII land where the limitations mentioned previously become so severe that they prohibit production afforestation. For instance, the erosion risk may be too high to permit the safe establishment and harvesting of forests. This occurs on all VIIIe land which, while it is unsuitable for production forestry, may require protection forestry for on-site and downstream protection purposes.

Other severe site limitations such as wetness, shallowness or absence of soil, the presence of rock outcrops and boulders, steep slopes, or severe climatic conditions, also preclude production forestry. Land in Classes IV, V, VI and VII with severe wetness limitations, as well as other land where 's' or 'c' limitations are severe enough also prohibit production forestry.



International Harvester Company

Rural valuations and property transactions

When assessing the value of a property the valuer has to determine both the "land value" which is the value of the land without structural improvements, and the value of the improvements, such as fencing, buildings, dams, trees and shelter. The combined value represents the capital value of the property.

Factors which are considered in arriving at the land value include the climate, the location of the property in relation to services, the extent to which it has been developed and the ease with which any potential can be realised taking into account the existing vegetation and topography. All these factors can then be related to those of comparable land in the same locality which has been sold recently.

The worksheets can be used by valuers to check and/or to determine both the land classes and the extent of each individual land class.



Campbell Commercial Photography Limited

Example 24

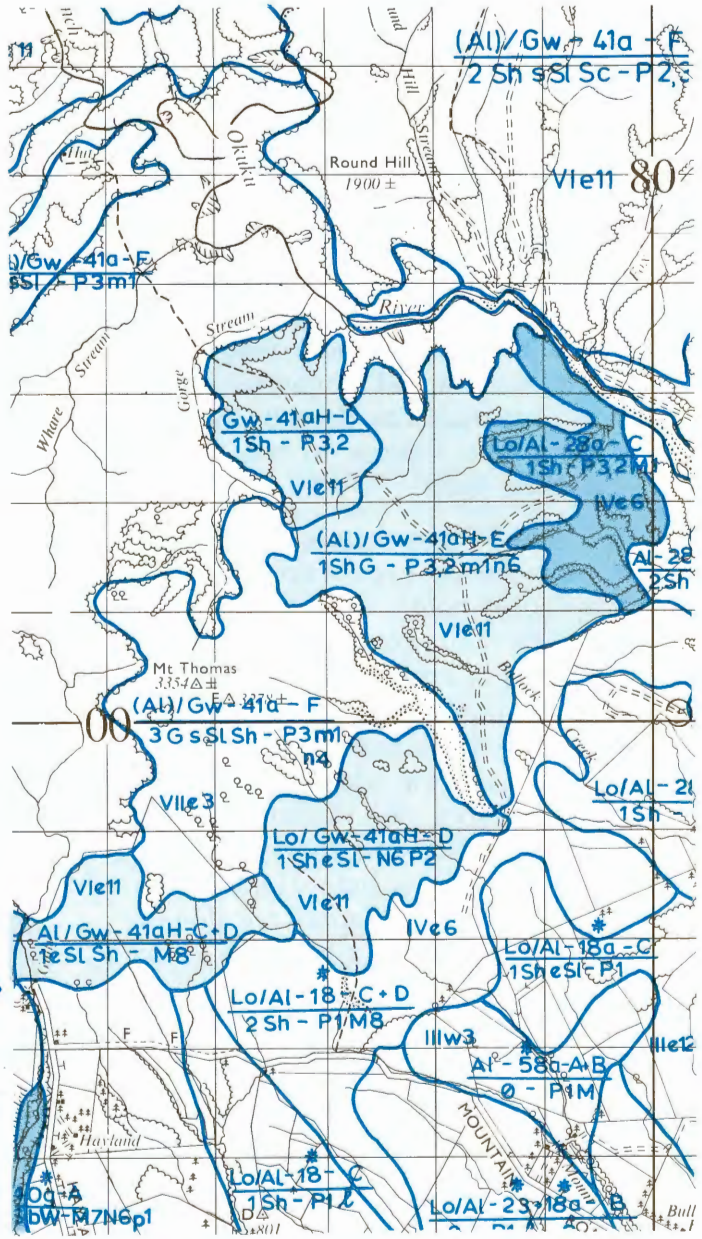
A firm of rural valuers or land agents may wish to find areas of presently undeveloped land that could readily be brought into agricultural production by prospective clients. From the worksheets and accompanying extended legends they can find out those undeveloped areas that are arable (Classes I-IV) or, of those that are non-arable, which would give a good economic return if topdressed (Classes V-VI).

Property boundaries can be superimposed on the worksheets. From this it is possible to identify areas under various tenure which have potential for subdivision and development by clients.

KEY:

Classes I-IV – undeveloped.

Classes V-VI – undeveloped.



Assessing production potentials

As the land use capability unit groups together land inventory units which have closely similar and uniform physical characteristics, it is a very suitable land grouping on which to base potential productivity values. Potential stock-carrying capacities, yields of particular crops or forestry site indices may be assessed from a physical standpoint and assigned to each land use capability unit.

This information can then be compared with present production values to ascertain the capacity for increased production from an existing form of land use, or potential production from an alternative land use. It also enables the potential production from any form of land use to be assessed for a given area such as a county, district or region.

Factors such as the managerial ability of landowners, location, certain economic factors, markets, etc., do not form part of such a primary assessment. They are, however, factors which can be super-imposed on the primary physical information.

This method of assessing production potentials has been used by the Ministry of Agriculture and Fisheries to assess the potential for agriculture in Northland and in other regions. For the Northland assessment land use capability units were grouped into three categories of arable land, three of non-arable land, and one class of protection land, according to potential use. An estimate of the area of each of the six productive land categories was made as well as a statement of the expected carrying capacity and production based on the levels produced by the top 10% of farmers. This exercise has enabled, for the entire Northland region, an assessment to be made of potential agricultural output on a county by county basis.

As national coverage is attained this type of information will be able to be used by producer boards and equivalent organisations such as the Forestry Development Council or those concerned with energy requirements, to assist in shaping respective national planning and marketing strategies.

Example 25

Capability units have been shaded according to their potential for growing maize. (Hamilton Regional Planning Authority data).

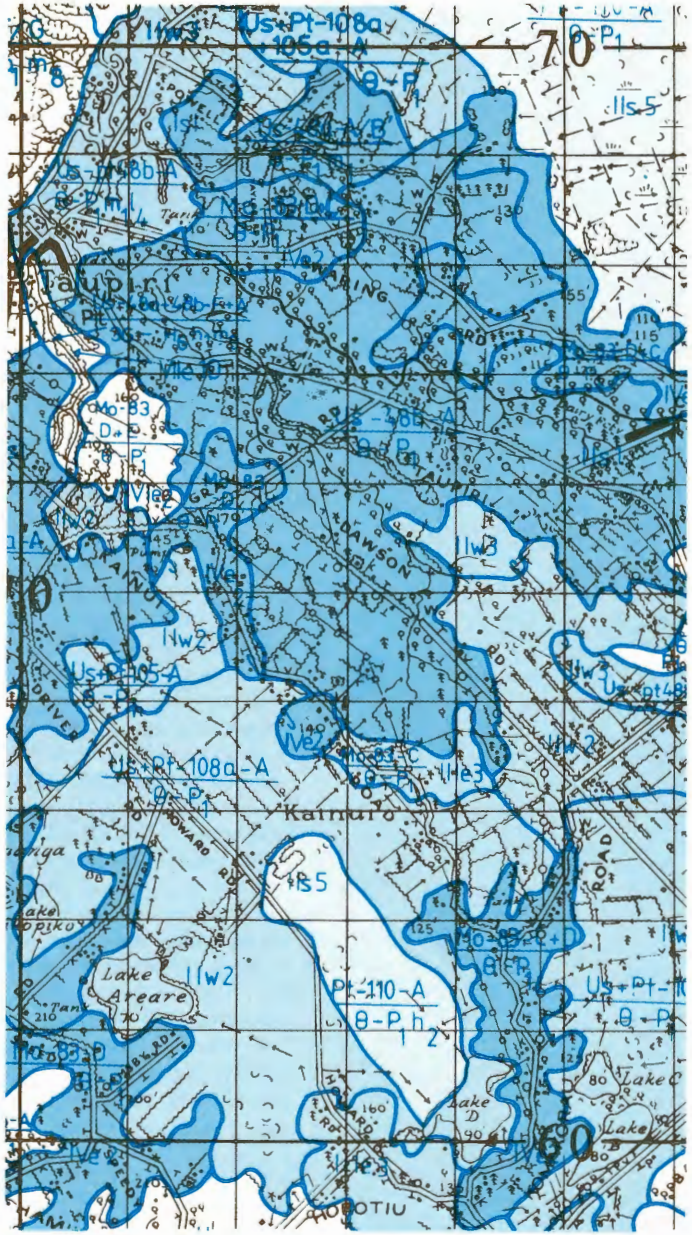
KEY:

Suitability for maize (H.R.P.A. Data).

Very high.

High.

Medium.



Advice for using worksheets

- It is essential that the worksheets be used either at the existing scale (1:63,360) or at less detailed scales (for example, 1:100,000 or 1:250,000). As with all maps, the worksheets should not be enlarged as they cannot then be relied upon to show boundaries with an accuracy appropriate to that more detailed scale.
- The 1:63,360 scale allows mapping units down to the order of 50-60 ha to be identified.
- For advice and detailed interpretive services, the local catchment authority should be consulted.

Glossary of Terms

alluvium — a general term for all detrital deposits resulting from the operations of modern rivers. Includes the sediments laid down in river beds, flood plains, lakes, fans at the foot of mountain slopes and estuaries.

andesite — an eruptive volcanic rock with intermediate silica content.

argillite — a rock derived either from siltstone, claystone, or shale that has undergone a somewhat higher degree of induration than is present in those rocks.

banded — the texture of rocks having thin and nearly parallel bands of different textures, colours or minerals.

basalt — an eruptive volcanic rock with low silica content. May contain pyroclastic deposits between lava flows. More generally, it includes any fine-grained, dark-coloured, igneous rock.

basic rock — a general, descriptive term for those igneous rocks that are comparatively low in silica.

beech — trees of the genus *Nothofagus*. Includes black, hard, mountain, red and silver beech. In the North Island beech can be conveniently categorised into: (a) lowland — mainly black and hard beech, with hard beech being dominant on the more exposed, drier sites. Red and silver beech are also found in this zone. (b) highland — mountain and silver beech.
In the South Island all five beech species are present, but there is no distinct separation into lowland and highland zones.

bentonite — a clay formed from the decomposition of volcanic ash. Composed largely of the clay minerals montmorillonite and beidellite. It commonly has great ability to absorb or adsorb water and to swell accordingly.

breccia — a rock made up of highly angular, coarse fragments.

coastal forest — native forest species found in coastal locations. For example, kohekohe, karaka and pohutukawa.

colluvium — a general term applied to loose and incoherent deposits, usually at the foot of a slope or cliff and brought there chiefly by gravity. Includes talus and cliff debris.

conglomerate — rounded, water-worn fragments of rock or pebbles, cemented together by another mineral substance, which may be of a siliceous or argillaceous nature.

conservation trees — tree species used specifically for erosion control. For example, poplars, willows and flame trees.

crystalline intrusive rock — rock consisting of minerals in an obviously crystalline state that has consolidated from magma beneath the earth's surface. Igenous rock that has crystallised at depth. For example, granite and gabbro.

debris avalanche — rapid flow of saturated regolith with a long, narrow slip plane on very steep slopes. The surface mantle disintegrates as it flows or tumbles downslope.

deposition — a build-up of material on an existing surface as an overflow during floods.

earthflow — rapid flowing of soil and underlying weathered material on moderate slopes. Characterised by an overthrust bulging dome at the toe, a depressed, fissured and disrupted centre upslope, and slipping or slumping at the head. Transverse cracks are prominent, particularly in the upper region of the movement.

earthslip — rapid downslope movement of soil and underlying material of considerable depth, usually on a relatively deep, concave, slip plane. Produces an irregular, hummocky mixture of incoherent fine material, blocks of unweathered parent material and turf.

erosion control forestry — (a) establishment of exotic forest species principally for soil conservation and water management purposes but with a variable component of production permitted. (b) management of indigenous forests principally for soil conservation and water management purposes but with some selective milling permitted (see also **protection forestry**).

gneiss — a coarse-grained rock in which bands rich in granular minerals alternate with bands in which schistose minerals predominate.

gravel — an accumulation of water-laid, rounded rock or mineral pieces ranging from approximately 2-16mm in diameter (as defined by New Zealand Soil Bureau, Department of Scientific and Industrial Research, and distinguished from stones and boulders).

greywacke — a type of sandstone marked by large detrital quartz and feldspars set in a clay matrix. It is generally tough and well-indurated, and has extremely angular detrital components.

gully erosion — the cutting of channels by water movement to a depth whereby they cannot be eliminated by ploughing. Other erosion forms that break the protective surface cover may help in the development of a gully.

hardwood — native broadleaf and narrow-leafed tree species. For example kamahi, tawa, taraire, rata, rewarewa, hinau, mahoe, kohekohe.

igneous rocks — rocks formed by solidification from a molten or partially molten state.

indurated rock — a rock hardened by cementation, heat or pressure.

intermediate rock — a general descriptive term for those igneous rocks that contain between 52% and 60% SiO_2.

jointed rock — rock containing fractures or partings which interrupt the physical continuity of the rock mass.

land inventory unit — the land contained by a boundary within which each of the physical characteristics recorded in the inventory is uniform at the scale of mapping.

land use capability class — the broadest grouping of the land use capability classification. It is based on the degree of limitation to permanent, sustained production.

land use capability classification — the classification of land according to its suitability for permanent, productive use, taking into account various physical limitations to use which the land may have.

land use capability subclass — the second grouping of the land use capability classification and a subdivision of the land use capability class. It divides the land within each class according to the major kind of limitation to use.

land use capability unit — the most detailed grouping of the land use capability classification. It groups together land requiring the same kind and intensity of conservation treatment.

lahar — a deposit produced by a landslide or mudflow of pyroclastic material on the flank of a volcano. Usually unsorted and composed of volcanic materials ranging from fine ash to huge blocks.

lapilli — pyroclastic material consisting primarily of particles 2-64mm in diameter.

limestone — sedimentary deposits consisting mainly of calcium carbonate.

lithology — the physical character of a rock. Rock type.

loess — a sediment, commonly non-stratified and unconsolidated, composed dominantly of silt-sized particles, ordinarily with accessory clay and sand, deposited primarily by wind.

marble — a metamorphic rock composed essentially of calcite and/or dolomite.

massive — occurring in very thick beds, free from minor joints and laminations.

metamorphic rock — rock which has formed in the solid state in response to pronounced changes of temperature, pressure and chemical environment, which generally takes place below the shells of weathering and cementation.

mixed native scrub associations — low to mid altitude native scrub species. Frequently these constitute regrowth vegetation after partial or complete removal of forest. They may be quite tall and may include species that are technically of tree form. For example, broadleaf, five-finger, lemonwood, wineberry, *Fuchsia* spp., *Hebe* spp., *Olearia* spp. and *Coprosma* spp.

moraine — detrital material deposited mainly by direct glacial action.

mud — a mixture of water with clay and/or silt together with materials of other dimensions. Particles are less than 1/16mm in diameter.

mudflow — rapid flow due to high water content of earth and rock down former stream courses.

mudstone — a consolidated mud.

pakihi associations — vegetation of Westland pakihi swamps. For example, umbrella ferns, sedges, ring ferns, mosses, manuka, kanuka, and podocarps.

pasture — a. high-producing (P1) — 'Sown pasture' — pasture with a medium to high dry matter production. Includes rye grass and white clover.
b. low-producing (P2) — 'Adventive grassland' — includes native grasses and browntop and other pasture species with low dry matter production.

peat — a dark, usually water-saturated, organic accumulation of partially decomposed plants in swampland.

physiography — the study and description of land forms (physiographic — description according to form).

podocarps — native cone-bearing (coniferous) forest species:
(a) lowland (below altitudinal limit of rimu, which ranges from 950m asl. in northern North Island, to 400m asl. in Fiordland). For example, kahikatea, rimu, totara, and miro.
(b) highland (above altitudinal limit of rimu). For example, Hall's totara, mountain toatoa, kaikawaka, and bog pine.

production forestry — the management of forests principally for commercial wood production.

protection forestry — the management of forests for soil conservation and regulation of water (see also **erosion control forestry**).

pumice — an excessively cellular, pyroclastic material formed in explosive, volcanic eruptions.

pyroclastic — a general term applied to detrital, volcanic materials that have been explosively or aerially ejected from a volcanic vent.

rhyolite — an eruptive, volcanic rock with high silica content — usually forms pyroclastic deposits but also occurs as domes and flows.

rill — a small channel created by surface water movement but which can be removed by cultivation.

rock-stratigraphic unit — stratigraphic unit defined and identified by lithologic or structural features without regard to fossils or time boundaries.

salt-tolerant associations — groups of plants able to grow in saline soils. For example, *Salicornia,* salt grass, sea barley grass, bullrushes and sedges.

sand — sediment consisting primarily of rock particles 0.02-2mm in diameter.

sand dune associations — groups of plants able to grow in sand dunes. For example, marram grass, *Spinifex,* pingao, lupin, broom, taupata, and yellow sand coprosma.

sandstone — a consolidated sand.

schist — a medium or coarse-grained metamorphic rock split up in thin, irregular plates and with a foliated structure.

scree creep — downslope movement of fragmental rock and soil at variable speed according to steepness of slope and content of binding material.

semi-arid herb associations — groups of plants typical of the dry mid and low altitude areas of Otago. For example, scabweed and thyme.

sheet erosion — the removal of topsoil from broad surfaces with no perceptible channels, by raindrop splash, frost heave and wind action.

silt — sediment consisting primarily of rock particles 0.002-0.02mm in diameter.

siltstone — a consolidated silt.

slump — rotational shear slipping of a mass of earth or debris moving as one or several units. Characterised by cracks and a drop at the head, backward tilting of the mass and upheaval at the toe.

soil slip — rapid sliding movement of the soil and subsoil roughly parallel to the surface. Depth is usually less than 1m.

stratigraphic unit — unit consisting of stratified, mainly sedimentary rocks grouped for any purpose such as description, mapping, correlation, etc.

streambank erosion — the loss of material from the bank of a waterway. This occurs mainly by undermining, resulting in bank collapse.

subalpine herb associations — generally non-woody plants above the altitudinal limit of subalpine scrub. For example, *Celmisia* spp., *Ranunculus* spp. and *Raoulia* spp.

subalpine scrub associations — stunted, woody vegetation above the tree line. For example, *Dracophyllum* spp., *Coprosma* spp., and snow totara.

swamp associations — plants of low-lying, wet ground. For example, rushes, sedges, toe toe, flax and sphagnum.

tephra — a collective term for all clastic, volcanic materials, which, during an eruption, are ejected from a crater or from some other type of vent and transported through the air. Includes volcanic dust, ash, cinders, lapilli, scoria, pumice, bombs and blocks.

tephric alluvium — water-deposited tephra.

tuff — a rock formed of compacted volcanic fragments generally smaller than 4mm in diameter.

tunnel gully erosion — subsurface erosion where water flowing beneath the surface creates tunnels. Associated vertical shafts may eventually collapse to form a gully.

ultramafic rock — a rock containing less than 45% silica.

ultramafite — a rock of varying ultramafic composition.

volcanic ash — an aerially-deposited, pyroclastic material, rich in volcanic glass, consisting of fragments less than 2mm in diameter.

wind erosion — removal of soil by wind, either in suspension (particles less than 0.1mm in diameter held in the air by turbulence), in saltation (bouncing along of particles 0.1-0.5mm in diameter), or as surface creep (particles 0.5-1.0mm in diameter pushed along by impact of saltating particles).

Vegetation — Botanical names

beech	*Nothofagus* spp.
black beech	*Nothofagus solandri* var. *solandri*
blackberry	*Rubus fruticosus*
broadleaf	*Griselinia littoralis*
broom	*Carmichaelia* spp.
browntop	*Agrostis tenuis*
celmisia	*Celmisia* spp.
coprosma	*Coprosma* spp.
dracophyllum	*Dracophyllum* spp.
five-finger	*Neopanax arboreum*
flame trees	*Erythrina* spp.
flax	*Phormium cookianum, P. tenax*
fuchsia	*Fuchsia* spp.
gorse	*Ulex europaeus*
Hall's totara	*Podocarpus hallii*
hard beech	*Nothofagus truncata*
hebe	*Hebe* spp.
hinau	*Elaeocarpus dentatus*
kahikatea	*Podocarpus dacrydioides*
kamahi	*Weinmannia racemosa*
kanuka	*Leptospermum ericoides*
karaka	*Corynocarpus laevigatus*
kauri	*Agathis australis*
kohekohe	*Dysoxylum spectabile*
leatherwood	*Olearia colensoi*
lemonwood	*Pittosporum eugenioides*
lupin	*Lupinus arboreus*
mahoe	*Melicytus ramiflorus*
mangrove	*Avicennia resinifera*
manuka	*Leptospermum scoparium*
marram grass	*Ammophila arenaria*
matagouri	*Discaria toumatou*
miro	*Podocarpus ferrugineus*
mountain beech	*Nothofagus solandri* var. *cliffortioides*
mountain toatoa	*Phyllocladus alpinus*
olearia	*Olearia* spp.
pingao	*Desmoschoenus spiralis*
podocarp	*Podocarpus* spp.
pohutukawa	*Metrosideros excelsa*
poplar	*Poplus* spp.
ranunculus	*Ranunculus* spp.
raoulia	*Raoulia* spp.
rata (northern)	*Metrosideros robusta*
rata (southern)	*M. umbellata*
rewarewa	*Knightia excelsa*
rimu	*Dacrydium cupressinum*
rushes	*Carpha alpina, Schoenus pauciflorus, Juncus* spp.
ryegrass	*Lolium* spp.
salicornia	*Salicornia australis*
salt grass	*Puccinellia stricta*
sea barley grass	*Hordeum marinum*
scabweed	*Raoulia* spp.
silver beech	*Nothofagus menziesii*
snow totara	*Podocarpus nivalis*
sphagnum	*Sphagnum* spp.
spinifex	*Spinifex hirsutus*
sweet briar	*Rosa rubiginosa*
taraire	*Beilschmiedia tarairi*
tauhinu	*Cassinia* spp.
taupata	*Coprosma repens*
tawa	*Beilschmiedia tawa*
thyme	*Thymus drucei*
toatoa	*Phyllocladus glaucus*
toe toe	*Cortederia toe toe*
totara	*Podocarpus totara*
tussock	*Chionochloa* spp.
umbrella fern	*Gleichenia circinata*
white clover	*Trifolium repens*
wineberry	*Aristotelia serrata*
yellow sand coprosma	*Coprosma acerosa*

References

Campbell, D. A., 1951: Types of erosion prevalent in New Zealand. *Association Internationale d'Hydrologie Scientifique, Assemblée générale de Bruxelles Tome II.* pp. 82-95.

Hamilton Regional Planning Authority, 1976: "Hamilton regional planning scheme". Scheme prepared by Gabites, Alington and Edmondson, Planning Consultants, for Hamilton Regional Planning Authority, Hamilton, New Zealand.

McCaskill, L. W., 1973: *Hold this land – a history of soil conservation in New Zealand.* Reed, Wellington. 274p.

Soil Conservation and Rivers Control Council, 1971: "Land use capability survey handbook". Ministry of Works and Development, Wellington, New Zealand.

Acknowledgements

Water and Soil Division scientists have worked in teams carrying out the National Land Resource Survey, formulating its complementary, computer-based land resource information system and preparing associated publications.

At any given time there has been approximately six scientists involved in worksheet compilation at each of the two science centres.

The total list of all who have been involved is as follows:

HEAD OFFICE:

K. J. Mitchell	Research Director; BAgrSc; PhD
G. Howard	Manager, Research and Surveys, Land Resources; BSc(Geology); DipAgrSc
S. D. Walsh	National Co-ordinator; BAgrSc
J. H. Lawrence	MA (Geography)
P. G. Luckman	BSc (Hons) (Geology)
S. L. Marx	BSc (Hons) (Geography)

NORTH ISLAND (Aokautere Science Centre)

G. O. Eyles	Group Leader; BSc (Botany); DipAgrSc
P. M. Blaschke	BSc (Hons) (Botany)
A. M. Campbell	BSc (Earth Sciences)
G. R. Driver	BAgrSc
J. R. Fletcher	BSc (Botany); DipAgrSc
M. R. Jessen	MSc (Hons) (Earth Sciences)
K. E. Noble	BSc (Earth Sciences)
M. J. Page	BSc (Hons) (Botany)
M. S. Redpath	BSc (Earth Sciences)
A. J. Reid	BAgrSc (Hons)
M. J. Robins	BSc (Geology)
P. R. Stephens	MAgrSc (Hons)
N. A. Trustrum	BSc (Geology); Dip Soil Survey
L. E. Whiley	BAgrSc
J. E. T. Wood	BA (Hons) (Geography)

SOUTH ISLAND (Christchurch Science Centre)

G. G. Hunter	Group Leader; BSc (Hons) (Botany)
R. C. Prickett	BAgrSc
L. R. Basher	BSc (Geology); DipAgrSc
J. A. Buckler	BAgrSc (Hons)
J. Grossman	BSc (Botany, Zoology)
J. B. J. Harrison	BAgrSc
M. D. Harvey	MAgrSc
P. H. Hill	MSc (Hons) (Geology)
J. N. Leith	BA (Geography)
I. H. Lynn	BSc (Hons) (Geology)
T. W. Marshall	MSc (Hons) (Geology)
R. K. Maw	BAgrSc
R. I. McPherson	MS (Hons) (Geology)
K. W. Steel	BForSc
P. R. Van Berkel	MSc (Hons) (Mathematics)
N. M. Williams	BScAgr

Thanks are expressed to the staff of catchment authorities throughout New Zealand who have made material contributions by providing valuable cross checks of information, assisted with transport and field work, arranged access to properties and supplied information and knowledge.

Thanks are also expressed to the Ministry of Agriculture and Fisheries and New Zealand Forest Service for co-operative establishment of agricultural and forestry production potentials, and to other scientific agencies who gave much time in assisting, especially the staff of New Zealand Soil Bureau and New Zealand Geological Survey, Department of Scientific and Industrial Research.

The assistance of the Department of Lands and Survey in providing aerial photographs and topographic base maps is gratefully acknowledged.

Thanks are also extended to all those who have provided photographs for this publication.

"The land is man's oldest heritage. . . . We do not 'possess' the earth or any portion of it, no matter what is written in the title deeds. Borrowing from it, while we live above it, we are at the most leaseholders for life.

In commerce, dealing with human beings, we may pit our brains against them and traffic as we will; we may persuade, coerce, trick, serve or enlighten people according to whether our ends be ideal or unworthy. But the earth cannot be fooled. Abuse it, and you eventually lose everything, leaving posterity a headache. Work in honest intelligent co-operation with it and you may have all that it can produce and those who follow on will say that you have been a good husbander.

That is a fine epitaph, awarded to few, for the ancient art of husbandry is not always held in esteem."

Anon.

P. D. HASSELBERG, GOVERNMENT PRINTER, WELLINGTON, NEW ZEALAND—1979
31660E—9,000Bks/6/79D

