SOILS OF MARLBOROUGH

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Marlborough is a particularly interesting province because it is the meeting ground for the soils and the farming from the North and South Islands of New Zealand. The central Awatere and Wairau districts have a landscape succession of coastal plains, downlands, hills, inland basins, and mountain slopes with similar soils, crops, and grassland usage to Canterbury. East and west of these districts the Kaikoura and Sounds regions have extensive areas resembling those of Wellington and Wairarapa hill country in soils, grassland farming, and forestry. Further contrast to the soil pattern is added by soils formed from basaltic, ultrabasic, and limestone rocks, which outcrop over small areas. After more than 100 years of settlement the land use has become related generally to the soils, but the connection could be much closer and to greater benefit, if the soil differences were better known and applied to the selection of farm practices. With the wide range of soil occurring in Marlborough, landowners need an understanding of their soils to select where best to apply experience from other districts and how to modify their practices to suit changing economic conditions.

The soils of parts of Marlborough have been described in detail in publications listed on page 17. This paper is intended to summarise the available information and to indicate the principal soil differences and their importance to land use. For this purpose, the soils are divided firstly on whether they occur on flattish lands or on rolling hilly and steep lands. This separates soils that have been built up by additions of materials to the surface from those where removal of materials is lowering the surface. The soils on rolling hilly and steep lands are further subdivided according to the effects of differing climates or rock materials in forming the chief properties.

SOILS OF FLAT LANDS

Flat lands comprise flood plains, beaches, swamps, and low terraces which total about 250,000 acres or 9 per cent of the province. Along the river channels and beaches, where accumulation is rapid, the deposits are stony or sandy with drainage that is too rapid for sustained plant growth. These soils are best used for recreation or as grassed flood reserves. On adjacent flood

plains deep sandy or silty deposits have been built up in shallow layers over many years. Near the river banks they arc friable free-draining soils well supplied in most plant nutrients and capable of growing a wide variety of crops. They are easily made highly productive and deserve maximum protection from further flooding or from encroachment by housing or industry.

On low-lying flats or those receiving runoff and seepage from adjacent hillsides the soils are wet for considerable periods and develop pale grey cloddy subsoils. Tn depressions where the soils are always wet, topsoils are peaty as a consequence of slow decomposition of dead vegetation. Near the mouth of the Wairau River, Lake Grassmere, and Havelock pastures and crops may be injured by salts brought into the soils through saline ground water. All these soils are well supplied in plant nutrients and, with adequate drainage to maintain aeration, will grow excellent crops and pastures, but they are suited to a smaller range of crops and more limited periods of grazing than the well drained river flats.

Old alluvial plains formed by post-glacial rivers but now above flood level through deepening of river channels form extensive terraces along the sides of the valleys. The soils are mainly light stony loams formed from thin deposits of loess over gravelly alluvium. Drainage is rapid and irrigation needed for sustained high production. Without irrigation they can grow fodder crops or early. or late season pastures for grazing after lambing or while adjacent hill country is being spelled. Phosphate and lime are required, except on the Seddon terraces, where the windblown silt deposits are thick and the silty soils are as rich in nutrients as river flats but do not have as good moisture conditions for plants. On all soils of terrace lands wind erosion is a serious hazard after cultivation and should be minimised by planting shelter belts.

The soils of the flat lands are formed from materials which have accumulated recently and have only a short history. Since deposition some constituents have been washed down by percolating solutions and some have been raised up to the surface through absorption by plants and return in dead leaves, branches, and bark. Decomposition of surface organic matter and of roots has added humus and helped the continued wetting and drying to form aggregates. But these losses and gains have had insufficient time to make large changes and the main change is the humus accumulation in the topsoil. The oldest soils are on the terraces and as a penalty of their greater age, the mineral nutrients are generally lower than in river flats formed from similar materials. This trend is expressed more fully on soils of adjacent rolling lands.

SOILS OF ROLLING, HILLY, AND STEEP LANDS

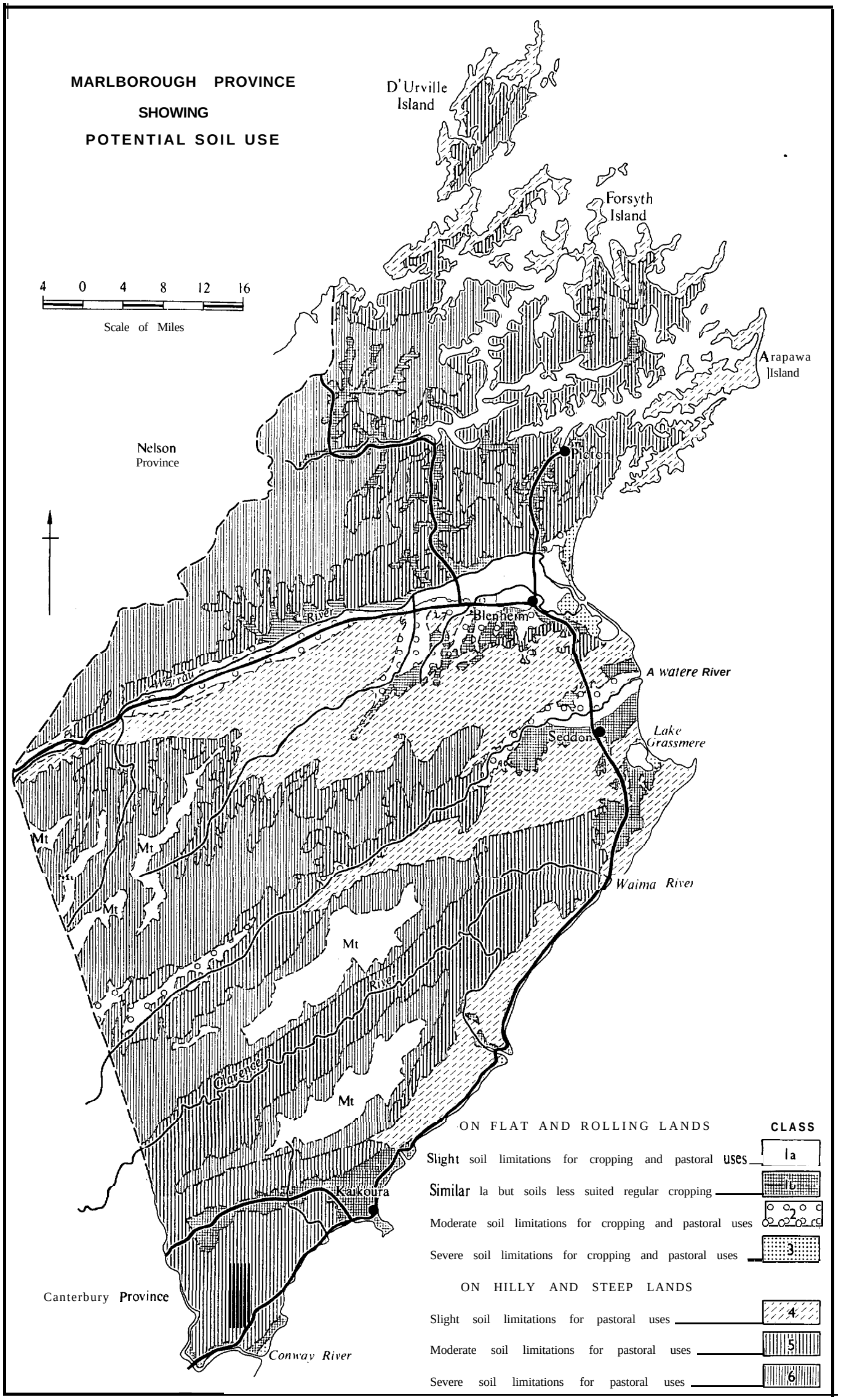
On sloping lands there is generally little addition and much removal of mineral material, which over the centuries results in a gradual lowering of the land surface. In this way the underlying materials gradually come closer to the surface and are progressively converted into soils. Minerals to replace those removed by soil processes are obtained from underneath the soil and the degree of mineral alteration increases towards the surface. This method is the opposite to that on river flats, where soils have been built up by periodic accumulation and the surface soil is the least altered part of the profile. The alterations in forming soils from rock materials are carried out principally by actions derived from climate and organisms. These factors control the rates of decomposition of substances and the amounts moving up and down the soils. The periodic deposition of materials on river flats interrupts these actions, which consequently have but little effect. But on sloping lands these actions are the main processes of soil formation and provide a basis for broad classification. Locally there are important differences due to rock materials or to increasing slopes, which are shown on detailed soil maps.

Soils of the rolling, hilly, and steepland are divided firstly into two broad regions called *high country* and low *country.* In the high country there is a distinct winter dormant period in plant growth, which is of only short duration in the low country. Low country lands extend inland from sea level to about 2,000 feet, but reach higher on sunny slopes and lower in valleys shaded by high mountains or where cold air is trapped. Thus high country extends down to about 1,000 ft in the middle Clarence Valley between the Seaward and Inland Kaikoura Ranges. The gradation from one region to another usually extends over a mile or two of land. Within each region three subdivisions are recognised according to general climatic conditions of (a) marked dry season, (b) weak dry season, and (c) no dry season. These subdivisions occupy successive belts of land inward from the coast and along the main valleys. The belts cross the geological grain of the district and the sequences of soils (such as Haldon-Hurunui-Patutu steepland soils derived from greywacke) demonstrate the dominating influence of climate and vegetation on soil development in Marlborough.

SOILS OF THE LOW COUNTRY

Soils of the low country with a marked dry season occur in a strip six to eight miles wide along the south side of the Wairau Plains to the coast at White Bluffs and from there along the coast to the mouth of the Waima River. Topsoils are greyish brown silt loams or sandy loams with a weakly developed fine granular

MARLBOROUGH PROVINCE
SHOWING
POTENTIAL SOIL USE



ON FLAT AND ROLLING LANDS — CLASS

Slight soil limitations for cropping and pastoral uses — 1a

Similar la but soils less suited regular cropping — 1b

Moderate soil limitations for cropping and pastoral uses — 2

Severe soil limitations for cropping and pastoral uses — 3

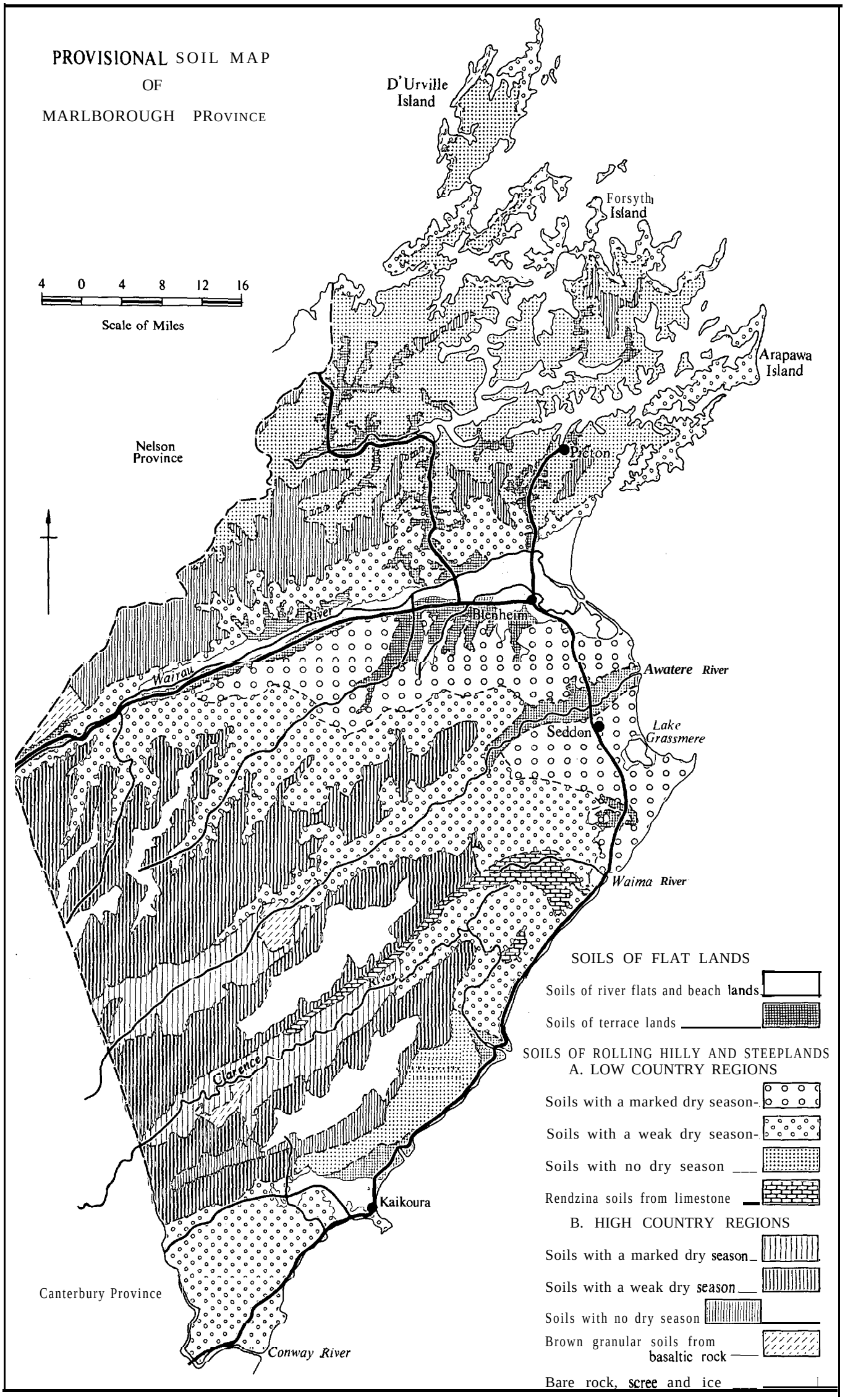
ON HILLY AND STEEP LANDS

Slight soil limitations for pastoral uses — 4

Moderate soil limitations for pastoral uses — 5

Severe soil limitations for pastoral uses — 6

PROVISIONAL SOIL MAP OF MARLBOROUGH PROVINCE



structure. Below 7 in. topsoils grade into yellow clay loams that are compact and have distinct grey and reddish yellow mottles. These soils receive an annual rainfall of 20 to 35 in., but under the warm temperatures with frequent drying winds most of the water absorbed by soils is returned to the air by transpiration or evaporation. Under these conditions solution losses are small and nutrient content ranges from high in Ward and Wharanui soils derived from mudstones to moderate in the rapidly permeable, stony Waihopai soils. Phosphate is generally low except on slopes facing dry riverbeds from which dust is being blown.

Crop and pasture yields are commonly limited by moisture and consistently high crop yields depend on conservation of moisture through the maintenance of organic matter, dense vegetation and contour cultivation. Subterranean clover is essential in pastures and close grazing of swards should be avoided to check runoff and prevent soil erosion. On the Wither Hills severe sheet and tunnel-gully erosion occurred when the surface was bared by burning and overgrazing of the native tussock grassland.

This subdivision includes the Ward, Sedgemere, Seaview, Wither, Flaxbourne, Weld, Haldon, and Waihopai soils, which are classed with yellow-grey earths and related steepland soils. Similar soils are extensive in east coast districts from Hawkc's Bay to Otago.

Soils of the low country with a weak dry season occur in a strip four to six miles wide immediately inland of the soils with a marked dry season. This strip continues northward of the Wairau River to exposed coastal parts of the Sounds and southward along the Kekerengu-Kaikoura coast to the Canterbury border. Topsoils are brownish grey to gcey silt loams or sandy loams which below 5 to 7 in. grade into pale yellow silt loams or silty clay loams. Prominent grey or reddish yellow mottles occur in the subsoils which are slightly compacted.

These soils receive an annual rainfall of from 30 to 50 in. irregularly distributed, so causing short droughty periods, especially on the steeper slopes. But there is a moisture surplus above transpiration and evaporation that produces considerable loss of nutrients and fertility ranges from moderate in the slowly permeable Medway soils derived from mudstones to low in the stony Hundalee soils.

Phosphorus is low and topdressing is needed to maintain pastures on the rolling and hilly lands. The fertility of soils on steep slopes is generally moderate, but only the soils with the granular structure developed under tussock grassland (Hurunui soils) are easily and safely converted to pastoral use. The soils

formed under beech forest (Onamalutu and Tekoa soils) have a shallow silt loam topsoil with a weak nutty structure that is more suited to forest than to grassland. Many attempts to convert these soils to pastoral use have resulted in severe sheet erosion and invasion of hillsides by manuka and gorse. However, a granular structure can be acquired under pasture established and maintained by phosphate topdressing and rotational grazing with other soils. Where these requisites are not available on account of cost or lack of associated lands with supporting pastures, these steepland soils do not make permanent pastoral lands and are better suited to timber production. These low country soils with a short dry season are classed as intergrades between yellow-grey and yellow-brown earths and their related steepland soils. In addition to the soils mentioned above they include the Jordan, Medina, Kahutara, Tuamarina, Kekerengu, and Arapawa soils.

Soils of the low country with no dry season are extensive in the Sounds County and in the Puhipuhi district near Kaikoura. They are mainly steep lands with brown silty topsoils grading below 5 in. into yellowish brown to yellow silty clay loams. The soils are friable and always moist, but are strongly leached of nutrients under the annual rainfalls of 50 to 80 in.

Up to altitudes of about 1,000 ft grasses establish readily on land cleared of tawa-podocarp forest, but phosphate topdressing and controlled grazing are necessary to maintain pastures against invasion of fern or loss by frequent slip erosion. At higher altitudes and on soils developed under beech forest the shallow, poor soils provide very difficult conditions for establishment of grasses and many cleared areas of these soils are severely eroding or have reverted to second-growth forest. All these soils provide good conditions for timber production, which would be less costly than pastoral farming, yet, over a period of 20 years, equally as valuable. This subdivision includes the Kenepuru, Opouri, Pelorus, Patutu, Charwell, and Puhipuhi soils which are classed with central yellow-brown earths and related steepland soils also extensive in the southern half of the North Island.

The low country between Cape Campbell and Amuri Bluffs includes discontinuous strips of steep lands with soils derived from limestones. These soils are firm stony clay loams with well developed structures. Near the coast the soils are black but become brown inland under the more moist climates. They are high to moderate fertility soils that can maintain pasture with little difficulty.

SOILS OF THE HIGH COUNTRY

Soils of the high country with a marked dry season occur in the upper Awatere and middle Clarence valleys. Topsoils are greyish brown sandy loams over brownish yellow stony sandy loams. Subsoils on rolling and hilly lands are slightly compacted with faint grey mottling. These soils receive an annual rainfall of 20 to 30 in., but with the general cool temperatures there is less evaporation and more leaching of nutrients than under a similar rainfall at Seddon in the low country. However, the nutrient content or the nutrient and granular structure of the soils are favourable to the growth of crops and pastures suited to dryland farming. Unfortunately large areas have been severely eroded of topsoil through depletion of the native short tussock by burning and overgrazing. A long period of spelling and careful management of the subsequent grazing are needed to establish pasture plants again.

The Molesworth, Mullet-, Clarence, and Acheron soils are included in this subdivision, which may be classed as high country yellow-grey earths and comparable with soils of the Omarama district.

Soils of the high country with a weak dry season are extensive on the sides and crests of the ranges in the upper Wairau, Awatere and Clarence valleys. They have brown friable loamy topsoils over yellow very friable stony loam subsoils. Annual rainfalls are between 40 and 80 in. and frosts are frequent. These soils occur under snow tussock grassland and erode rapidly if the tussock cover is depleted.

A survey showed 500,000 acres of Kaikoura steepland soils in Marlborough most of which had lost more than half of the topsoil. The subsoils are extremely poor and erosion increases the difficulties in procuring a protective cover for the soils before they are eroded into screes. The snow tussock is not suited to grazing without baring the soils to erosion and no grazable replacement plants have yet been established. Until trials on the effectiveness of fertilisers or on suitability for forestry give satisfactory results, these soils are not considered to be suitable for pastoral use. Even light summer grazing increases the erosion hazard and runoff into the rivers.

These soils are included in the Kaikoura and Puketeraki sets and classed as high country yellow-brown earths.

Soils of the high country with no **dry season** are extensive on the Richmond Range north of the Wairau River and on high ridges of the Sounds district. They are mainly on steep slopes with a shallow **mat** of slowly decomposing organic matter over the surface derived from either the beech forest or the subalpine

carpet grass. Below this mat there is a shallow mineral soil consisting of dark brown to pale grey sandy loam over reddish brown to yellowish brown stony loam, On rolling slopes thin iron pans occur above the reddish brown subsoil. These are very poor soils formed under annual rainfalls of 80 to 150 in. and low mean temperatures.

Clearing of the native vegetation results in rapid erosion of the fine soil and the formation of screes. The surface mat of decomposing organic matter is essential for the protection of these soils and must be maintained as intact as possible. This requirement precludes productive use and supports reservation of the lands as protective forests for water supplies.

The soils of this subdivision are mapped in the Patriarch and Spenser sets and classified as steeplands related to podzolised high country yellow-brown earths.

Soils derived from volcanic rocks occur in three large areas of the high country and in narrow strips of low country bordering the Nelson district. Middlehurst soils formed from basaltic lavas exposed in the Awatere and Clarence Valleys are reddish brown stony clay loams with a well developed fine granular to nutty structure. They are high in nutrients, notably potassium, and originally carried a dense cover of short tussock grassland. Burning and overgrazing of this grassland has resulted in some serious sheet erosion but with spelling, tussock and soil regenerate rapidly and become capable of permanent pastoral use.

Dun soils are formed from serpentine rocks that outcrop on the Red Hills in the upper Wairau Valley and in narrow strips of the western Sounds. They are brown friable silt loams that contain unusually large amounts of elements such as magnesium and chromium, but are very low in calcium and potassium. Detrimental effects of the chemical conditions are demonstrated by the native vegetation of stunted shrubs, whereas adjacent soils have dense forest. Until methods of correcting the nutrient problems are known and applied the soils are unsatisfactory for pastoral or forestry use,

POTENTIAL USES

The relative value and the problems of Marlborough soils are summarised in the following classification for potential use. It is an interpretation based on existing knowledge of soil properties and can be modified by more detailed work on soils, crops, or methods of management. It is not a recommendation for actual land use which takes into consideration location, costs of production, marketing prospects, and other factors outside the scope of soil research. The soils are placed into six classes, three for flat

and rolling lands and three for unploughable hilly and steep lands. Each trio is divided on the degree of limitation for use imposed by soil properties.

Class 1 comprises soils of flat and rolling land with slight limitations to cropping or pastoral uses. It includes all the deep, fine-textured soils of flat lands and of low country downlands except the marsh lands with saline ground water. With topdressing and drainage, where required, these soils will give high yields of pastures and some'crops. A special subdivision (1A) is made for the Wairau, Opawa, Spring Creek, Omaka, and Seddon soils, which are suited to regular cropping and amount to only 30,000 acres out of a total of 193,000 acres for Class 1. From a provincial and national point of view it is a great pity that the floods and fires did not shift the location of the township of Blenheim to more stony land in the Wairau Valley.

Class 2 comprises soils of flat and rolling land with moderate limitations to cropping or pastoral uses. It includes the stony soils of the terrace lands where productivity and use are limited by seasonal deficiencies of moisture, and the ploughable lands of the high country on which seasonal growth is limited by temperature. This class is estimated to cover 119,000 acres or 4 per cent of the province.

Class 3 comprises soils of flat and rolling lands with severe limitations to cropping or pastoral uses. It includes the gravelly soils of the river beds and beaches and the saline river flats. The estimated area is 52,000 acres (2 per cent of the province).

Class 4 comprises soils of hilly and steep lands with slight limitations to permanent pastoral use. This includes all the soils of the native grassland of the low country hills and those of the forest lands which develop a granular structure readily. On all these soils little topsoil need be lost during the conversion of the native vegetation to pasture grasses. Topdressing is not essential, but is beneficial on all these soils. Commercial forestry would be successful on soils developed under forest, but not on those developed under tussock grassland. The estimated total area of soils in Class 4 is 65 1,000 acres (24 per cent of the province).

Class 5 comprises the soils of hilly and steep lands with moderate limitations to permanent pastoral use, It includes the hill country soils on which soil erosion, weed invasion, or both vigorously oppose pasture establishment and maintenance. On the high country and Wither soils the problem is soil erosion due to slow regeneration of vegetation under low moisture or temperature conditions and continued intensive grazing, Specialised pasture plants and management are required for successful use of these soils. On the Hundalee, Kahutara, Tuamarina, Onamalutu,

Kenepuru, Opouri, and Tekoa soils the rate of conversion of present soil properties to grassland requirements is slow and during the interim period losses of topsoil by erosion may be large enough to prevent pasture establishment. With topdressing and careful management permanent pastures can be obtained, especially where good pastures are available on class 1, 2 or 4 soils on another part of the farm. On their own these soils are really not suited to pastoral farming, and are more suited to growing timber. The soils of class 5 are estimated to cover 815,000 acres (29 per cent of the province).

Class 6 comprises soils of hilly and steep lands with severe limitations to permanent pastoral use. It includes the Kaikoura, Patriarch, and Spenser steepland soils of the moist to wet high country and parts of the Pelorus and Opouri steepland soils of the wet low country. These are strongly leached poor soils that erode rapidly if the native vegetation is removed. Pastures would be extremely difficult to maintain and growth of exotic trees would be slow. Hence the areas of these soils, amounting in all to 919,000 acres, should be retained in native vegetation for flood control and water supplies. Reservation of this proportion (33 per cent) of a mountainous province is not unreasonable in comparison with other countries.

Thus, from a soil point of view, Marlborough is a wealthy province. Future progress lies in:

(1) Retaining the maximum amount of the relatively small area of first-class cropping soils for intensive farming. They can be adapted to growing crops more easily and efficiently than other soils.

(2) Mixed farming on deep soils of other flat lands and pastoral use of the large area (approximately 800,000 acres) of rolling and hilly land of moderate to high fertility. In most seasons productivity is limited by drought and more attention should be given to selection of plants and methods of moisture conservation to get maximum benefit from the rainfall.

(3) Using small areas of flat lands adjoining the poorer hill country (815,000 acres) to maintain soils and pastures on those hills.

(4) Afforestation of the poorer hill country which is without adequate supporting land or has been seriously eroded. Timber supplies are needed and will support families equally as well as farming on many of the soils.

(5) Maintaining permanent reserves in upper catchments and wetter regions for control of water and of erosion.

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DISCUSSION

Q. (G. Robinson): I understood Mr Gibbs to say that the failure of pastoral farming of high country soils with high rainfall was due to the use of unsuitable grasses. Was this associated with the attempted introduction of English grasses where tussock should have been retained?

A. Yes. On the Kaikoura soils tussock should be retained until grasses suited to the low nutrient and average temperature conditions of the soils can be maintained under grazing. The structure is excellent for grass growth but so far tussock grasses are the only ones to give sufficient cover to prevent rapid erosion. I understand that by using large amounts of fertiliser Dr O'Connor has been able to grow other grasses, but the cost of fertiliser is prohibitive for farming.

Q. (T. Ludecke): Are the soils in the dry areas of Marlborough similar to those of Central Otago?

A. The subsoils are fairly compact pale brown sandy loams rather similar to the soils in the Omarama and Clyde districts which can be considered as high country yellow-grey earths. They differ from brown-grey earths in being more yellow and having no sign of lime accumulation.