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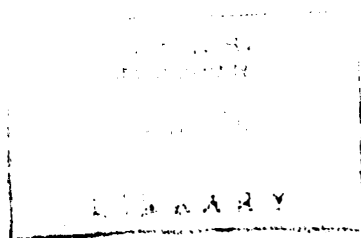
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DIVISION OF SOILS

**THE SOILS OF THE C.S.I.R.O. BEERWAH
EXPERIMENTAL AREA COASTAL LOWLANDS,
SOUTH EASTERN QUEENSLAND**

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THE SOILS OF THE C.S.I.R.O. BEERWAH EXPERIMENTAL AREA
COASTAL LOWLANDS, SOUTH EASTERN QUEENSLAND

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I. INTRODUCTION

The Beerwah Experimental Area (Andrew and Bryan, 1955), situated in the Coastal Lowlands about 45 miles north of Brisbane and 4 miles E.N.E. of the township of Beerwah, has recently been enlarged to about 70 acres to accommodate an expanding programme of field experimentation. This report covers a detailed survey of the area made at the request of the Agronomy section of the C.S.I.R.O. Division of Plant Industry as an aid to the location of plots and the interpretation of experimental results.

II. ENVIRONMENT

(a) Topography and Drainage.

As defined by Andrew and Bryan (loc. cit.) the Coastal Lowlands extend from the shoreline to the foothills of the coastal ranges. Hubble (1954) recognises two main land units within this area, the rolling to low hilly country of the western half and the very gently undulating plains extending eastward to the coastline. The experimental area lies within the rolling to low hilly country near its eastern margin and consists of low sandy rises and shallow swampy drainage depressions separated by gentle slopes. Maximum relief within the experimental area is approximately 35 feet, the lowest portions probably being about 25 feet above mean sea level. The country rock consists of massive Landsborough quartzose sandstones with some interbedded shales and is of Mesozoic age (Geological Map of the Moreton District, Department of Mines, Queensland 1955).

Drainage is generally poor and water-tables may be at, or near, the surface over much of the area during and following wet periods. The crests and upper slopes of the higher rises mostly have free drainage but even here some areas with perched water-tables may occur where vertical and lateral drainage are impeded.

(b) Climate.

The climate of the area is humid and sub-tropical with hot wet summers and cool to warm winters. Mean annual rainfall at Beerwah is 65.60 inches (Coaldrake and Bryan 1957: data adjusted to standard 30 year period) and has a strong summer incidence, but useful falls occur during the winter months. The chief rain bearing influences are the south-east trade winds, thunderstorms, and cyclonic disturbances. August is normally the driest month. Much of the summer rain occurs as heavy falls of high intensity which rapidly saturate the sandy surface horizons of the Beerwah soils and lead to high runoff from sloping sites.

More detailed climatic data for this area are presented by Andrew and Bryan (1955) and Hubble (1954).

(c) Vegetation

Most of the Beerwah Experimental Area has been cleared but the virgin cover of the surrounding area indicates that three or possibly four distinct vegetation formations were present.

(i) Eucalypt forest (40-60 feet tall)

Eucalypt forest occupies the ridge crests and upper slopes and is dominated by scribbly gum (Eucalyptus micrantha) and bloodwood (Eucalyptus intermedia) and some stringy bark (Eucalyptus sp.). There is a small tree and shrub understorey in which Pultenaea villosa and Acacia complanata are prominent and a thin to moderate ground cover of healthy plants and grasses.

(ii) Open Woodland (scattered trees 10-20 feet tall)

On the middle and lower ridge slopes an open woodland of scattered broad leaf teatree (Melaleuca sp.) and apple tree (Angophora sp.) occurs. There is a low, 1 to 3 feet tall, thrub layer of variable density (often widely spaced) which includes Hakea sp., fine leaf Melaleuca sp., Leptospermum sp., Callistemon sp. and Xanthorrhoea sp., and a thin ground cover of sedges and herbaceous plants. The open woodland grades into the margin of the swampy depressions where tree spacing is closer and the shrub layer is dense and somewhat higher.

(iii) Thickets (15-30 feet tall)

Dense thickets of swamp mahogany (Tristania suaveolens) and fine leaf tea tree (Melaleuca decora) occur along the wet bottoms of the swampy drainage lines. There is a dense shrub understorey of Leptospermum sp., Banksia robur, Hakea gibbosa, Pultenaea myrtoides, Callistemon pachyphyllus and Xanthorrhoea sp.

(iv) Heath

A small area associated with organic pan soils apparently supported a distinctive vegetation community. This area had been

cultivated before the survey was made but plants collected from the furrow suggest a heath-like vegetation. Species identified are: Leptospermum sp., Dillwynia floribunda, Aotus lanigera, Leucopogon sp., Sowerbaea juncea, and Xanthorrhoea hastilis.

Detailed studies of the plant communities of the area and their relationships have been made by Coaldrake (papers in preparation) as part of an ecological survey of the coastal lowlands.

III. THE SOILS

(a) General

The soils were examined and described from pits to a depth of two feet with auger holes to six feet, at half to four chain intervals along traverse lines two chains apart. Soil boundaries were drawn directly on to a one chain to the inch base map prepared by the Agronomy Section of the C.S.I.R.O. Division of Plant Industry.

Most of the area has been cleared by bulldozer and ripped to a depth of more than 12 inches, leaving the surface in a very disturbed condition and obscuring surface features associated with soil changes. The delineation of boundaries was difficult and many had to be located by numerous closely spaced holes. This was not practical in the fertiliser trial plots and boundaries through these have been placed from examinations outside of the plots supported by a few auger holes along pathways.

Though the total area surveyed is only 70 acres, 12 distinct soil units have been recognised and mapped. Differences between these units are of the order normally recognised at the soil type level of classification. However, none of the units is given type status because of uncertainty whether some of them will cover large enough areas to justify this. As the soil map is to be used as an aid to the interpretation of experimental results, individual occurrences of a fraction of an acre have been mapped where practicable. The mapping units are designated numerically in this report and on the map, e.g. Beerwah 7.

For the purpose of discussion the mapping units are grouped into higher classes at approximately great soil group level. The names of the groups used for this area and their relationship to recognised great soil groups of the current Australian (Stephens, 1956) and United States soil classification schemes are set out in Table 1.

TABLE 1

CLASSIFICATION OF THE BEERWAH SOILS

Soil Unit	Report Designation	Great Soil Group	
		Australian Classification *	American Classification +
Beerwah 1 Beerwah 2 Beerwah 3	Nodular podzolic soils	Lateritic podzolic soils	Red-yellow podzolics
Beerwah 4 Beerwah 5	Gleyed podzolic soils	Meadow podzolic soils	? Red-yellow podzolics
Beerwah 6	Low humic gley soils	Meadow podzolic soils	? Low humic gley soils
Beerwah 8 Beerwah 9	Humic gley soils	Acid swamp soils	Humic gley soils
Beerwah 7 Beerwah 10	Gleyed soils with texture contrast	Meadow podzolic soils	? Humic gley soils
Beerwah 11 Beerwah 12	Ground water podzols	Ground water podzols	Ground water podzols

* C.G. Stephens (1956)

+ Based on The U.S.D.A. Year Book "Soils and Men" 1938 and "Soil Science", Vol. 67, 1949

(b) Soil Descriptions

The main morphological features of the soil groups and units are summarized below and detailed profile descriptions of the individual units are given in Appendix 1.

(i) Nodular podzolic soils

These soils are characterised by fairly thick sandy A horizons, mottled yellow-brown and red sandy clay to heavy clay B horizons containing low to high amounts of nodules, and coarsely mottled light grey and red heavy clay B-C horizons with some red mottles hardened to form irregular nodules. There is slight organic accumulation as a thin A₁ horizon. The A₂ horizon is normally weakly defined and yellowish in colour, and horizon boundaries are generally diffuse.

Laboratory data for profile B.179 (Hubble, 1954) may be taken to generally represent the soils of this group. These soils are acid throughout, have a low exchange capacity with a low degree of metal cation saturation (31% in the A horizon and 38% in the B horizon in profile B 179) and calcium and magnesium as the dominant exchangeable metal ions. Their fertility level is low.

Beerwah 1 (loamy sand).— The distinctive features of this soil are dominantly yellow-brown colours in the A₂, B₁, and B₂ horizons, sandy loam or lighter texture to 42 inches, and mottled red and yellow-brown heavy clay below 56 inches. The surface is a dark brownish grey loamy sand which grades at 5 inches into pale yellow-brown loamy sand with a few nodules and, below 16 inches, into yellow-brown sandy loam with nodules. At 42 inches there is a texture increase to sandy clay which is dominantly yellow-brown with some fine red mottling. A gradual change to coarsely mottled red, yellow-brown, and light grey stiff-plastic heavy clay occurs below 5 to 6 feet.

This unit is restricted in occurrence to the crest and upper slopes of a small ridge extending into the area across the middle southern boundary. It supports a eucalypt forest dominated by bloodwood and scribbly gum. There are a few tall stringy barks and a short fairly dense understorey in which Pultenaea villosa and Acacia complanata are prominent. This is the best drained soil in the area, having very free surface and internal drainage.

Beerwah 2 (loamy sand).— This soil is distinguished from Beerwah 1 mainly by its sandy clay loam texture at 12 inches, sandy clay to medium clay texture at less than 33 inches, and a rather more definite A₂ horizon. The surface 5 inches is brownish or yellowish grey loamy sand grading into a light yellow-grey loamy sand A₂ horizon. At about 12 inches there is a gradual change to faintly mottled yellow-brown sandy clay loam with a few nodules. At 27 inches the texture increases gradually through sandy clay to medium clay with fine red mottling and some nodules. The B-C horizon below 40 inches is a coarsely mottled, red and light grey, plastic heavy clay. In this layer some red mottles have hardened to form irregular nodules.

Beerwah 2 occurs on the crest and upper slopes of the higher ridge in the western part of the area and on the upper slopes marginal to Beerwah 1. It is generally well drained, although some profiles show slight evidence of impeded drainage, possibly the result of partial saturation for short periods during very wet seasons. The surface $\frac{1}{4}$ inch shows a tendency to form a weak "crust" following heavy rain. The native eucalypt forest on this soil contains the same species as found on Beerwah 1 but here scribbly gum is apparently dominant.

A coarse sandy variant of this soil has been recognised in the 3 acre "Top Beerwah" area. It is distinguished by a larger coarse sand component throughout the profile and a somewhat brighter coloured B₁ horizon.

Beerwah 3 (loamy sand)..- A more definite A_2 horizon, large amounts of nodules in the B horizons, and greater coarse sand and fine gravel contents throughout, distinguish this soil from the foregoing units. Beerwah 3 has about 5 inches of brownish grey surface soil grading into a very light yellow-grey sand A_2 horizon with soft concretions and some nodules. At about 10 inches there is a fairly sharp change to a light yellow-brown sandy clay loam with many nodules. This horizon grades into yellow-brown sandy clay or medium clay with large amounts of nodules below 16 inches. With depth the texture increases, red mottles become numerous, and there is a gradual change at about 36 inches to the coarsely mottled very light grey, yellow-brown, and red stiff-plastic clay B-C horizon with few nodules. Variable amounts of coarse sand and fine water-worn silica gravel occur in all horizons.

This unit occurs only in the "Top Beerwah" area where it occupies the ridge crest and upper slopes in the south-eastern corner of the experimental plot. Surface drainage is free, but the profiles all show evidence of slightly impeded internal drainage. Perched water above the clay is to be expected for short periods after heavy rains. The native vegetation is similar to that on Beerwah 2 but includes some apple tree (Angophora sp.) and fine-leaf Banksia.

(ii) Gleyed podzolic soils

These soils occupy lower and wetter sites than the nodular podzolic soils and are distinguished by gley features of varying intensity, principally rusty root tracing in the A_2 and yellow-brown and light yellow-grey mottling in the B_2 horizons. They are related to the meadow podzolic group (Stephens, 1956) and may be regarded as being intermediate between the podzolic and gley types.

Distinguishing profile features are darker and thicker A_1 horizons than for the previous group, more definite A_2 horizons with weak gley features, a fairly sharp change to a prismatic structured B_2 horizon with gley characteristics, and a gradual change from this to coarsely mottled light grey and red stiff-plastic heavy clay with some red mottles hardened to nodules. The fertility level of these soils is expected to be similar to, or slightly lower than that of the nodular podzolic soils.

Beerwah 4 (loamy sand)..- This soil has a brownish grey surface horizon about 5 inches thick, a yellow-brown prismatic structured clay B horizon at about 13 inches, and mottled heavy clay below 33 inches. Gley features in the A_2 and B_2 horizons are characteristic.

The surface shows some faint rusty root tracings and grades into brownish white sand with prominent rusty root markings below 5 inches. At about 13 inches there is a sharp change to yellow-brown and yellow-grey mottled heavy clay of prismatic or blocky structure with light grey aggregate faces and much rusty root marking. Mottling increases with depth changing gradually at about 33 inches to light grey and red stiff heavy clay with few nodules.

Beerwah 4 occurs on slopes and on low saddles below units 1 and 2. Slopes are sufficient for adequate surface drainage but internal drainage is impeded by the clay subsoil. Intermittent saturation and slow lateral leaching of the A horizon would be expected during wet seasons.

The original vegetation was an open forest dominated by apple tree with some scribbly gum and bloodwood. Small leaved Banksia sp., Hakea sp. and Casuarina sp. occur as a shrub layer.

Beerwah 5 (loamy sand)..- This soil differs from unit 4 in having a greater thickness of A horizons (particularly the A_{2a}), a coarsely mottled sandy clay loam to sandy clay B_2 horizon with large nodules, and mottled light grey and yellow-brown heavy clay with coarse prismatic structure below about 30 inches.

The A_1 horizon consists of about 9 inches of dark brownish grey loamy sand with low organic accumulation and grades into a pale yellow-greysand A_2 horizon with prominent fine rusty root markings and some faint yellow-brown mottles. A slight texture increase to sandy loam at about 16 inches is followed by a gradual change to coarsely mottled light grey, yellow-brown and red sandy clay of weak prismatic structure. Low to large amounts of $\frac{1}{2}$ -3 inch iron-impregnated nodules occur below 21 inches. Below 30 inches the soil is coarsely mottled very light grey and red heavy clay with coarse prismatic structure and few nodules, changing gradually to mottled stiff-plastic clay at about 4 feet.

Beerwah 5 is found on gentle slopes in intermediate positions between the nodular podzolic and gley soils. In places it occurs as a strip only a chain wide, but becomes more extensive on the low saddles. Slopes are mostly sufficient for fair surface drainage but internal drainage is impeded by the clay subsoil and the upper sandy part of the profile is kept saturated for long periods during the wet season by lateral movement of water from higher sites. The pattern of mottling in the clay horizons suggests that during wet periods saturation in this part of the profile is confined to soil marginal to fissures separating the main structural units and to the more permeable parts of the soil mass.

In the virgin state Beerwah 5 supports an open woodland of apple tree and broad-leaf teatree with a sparse to fairly dense low shrub layer of fine leaf Banksia sp., Hakea sp., Casuarina sp. and Xanthorrhoea sp.

A coarse sandy variant, distinguished by its coarse sand component, is recognised in the "top" Beerwah area.

(iii) Low humic gley soils

The proposed group of low humic gley soils (Thorp and Smith, 1949) has been tentatively defined as "an intra-zonal group of imperfectly to poorly drained soils with very thin surface horizons moderately high

in organic matter, over mottled grey and brown glei-like mineral horizons with a low degree of textural differentiation".

The Beerwah 6 soil is tentatively grouped with these soils although it has textural differentiation in the lower part of the profile and rather thick A_1 horizons of low organic content. Depth of the A_1 horizons varies in the area and a profile in the shallower range has been previously included with low humic gleys (Hubble 1954). In the Australian classification, (Stephens, 1956) the Beerwah 6 soil is best placed as a poorly-drained meadow podzolic soil.

This soil occupies lower sites, has water-tables near the surface for longer periods and shows more pronounced gley features than the foregoing soils. The fertility level is very low, the soil being acid throughout with a low degree of metal cation saturation and a very low total phosphate content, (Hubble, 1954, profile B184).

Beerwah 6 (loamy sand).— Distinguishing morphological features of this soil are a rather thick A_1 horizon, a strongly-defined A_{2g} horizon with pronounced rusty root markings, and a fairly sharp change below about 24 inches to a predominantly light grey sandy medium clay of coarse prismatic structure.

The A_1 horizons are about 16 inches thick, have low organic contents and show some white sand speckling and few rusty root markings throughout. The A_{2g} horizon is 10 to 16 inches thick and often has free water in its lower part. The sandy medium clay below 24 inches is dominantly light grey in colour, grading with depth into mottled light grey heavy clay with a white sandy fill between the coarse prismatic units. Some profiles have been observed with cemented sandy material above the clay but these appear to be very patchy in occurrence and could not be mapped separately.

Beerwah 6 occupies gentle slopes marginal to the swampy depressions. Under virgin conditions surface drainage is slow and internal drainage is strongly impeded by the clay subsoil. Perched water saturates the A_{2g} horizon for much of the year, and the colour of the underlying sandy medium clay suggests that this horizon is normally wet.

The native vegetation consists of a few scattered broad-leaf tea-trees with a sparse to fairly dense ground cover of stunted Casuarina sp., Hakea sp., fine leaf Banksia sp., grass tree, and heath species 3 to 4 feet high.

(iv) Humic gley soils

The soils in the swampy depressions in the Beerwah area have slightly to strongly developed swampy hummock micro-relief and water-tables near the surface for much of the year.

These poorly drained soils have thick, dark coloured, organic surface horizons overlying strongly gleyed sandy mineral horizons. On

morphological features they are classified with the American group of humic gley soils.

Beerwah 8 (organic sandy loam).— The surface 24 inches is a fine blocky-structured organic sandy loam with some dark rusty-brown root marking in the lower part. This is followed by a white A_{2g} horizon with prominent bright rusty root markings and flecks. Below about 40 inches there is an abrupt change to very light grey sandy medium to heavy clay with coarse "pseudo-prismatic" structure. When the survey was made, free water was always encountered in the A_{2g} horizon and the colours of the deeper clay suggest permanent saturation of that zone.

Unit 8 occupies gently sloping to flat areas in the outer zone of the swampy depressions. Surface drainage is very slow and the soil receives run-off and seepage waters from all of the higher areas. Internal drainage is impeded by the clay horizon and perched water saturates the A_{2g} horizon and the lower part of the A₁ horizon for the wetter part of the year.

The native vegetation consists of scattered broad leaf teatrees and apple trees underlain by dense low thickets of fine leaf tea-tree (Melaleuca decora), with Hakea gibbosa, Banksia robur, Pultenaea myrtilloides, Xanthorrhoea sp. and Leptospermum sp.

Beerwah 9 (organic loam).— This soil occupies the bottoms of the swampy depressions and is distinguished from unit 7 by the organic loam texture and strongly developed granular structure of its dark A₁ horizons which are 24-30 inches thick. Below this there is a strongly leached and gleyed A_{2g} horizon, 12-24 inches thick, of white sand with a few faint yellow mottles. At about 4 feet there is a sharp change to light brownish grey heavy clay with coarse "pseudo-prismatic" structure. In some profiles white cemented sandy lumps with organic staining occur above the clay layer.

Surface drainage is very slow, and internal drainage is strongly impeded by the deep subsoil clay. As a result water fills the depressions between the hummocks during the greater part of the wet season.

Native vegetation is similar to that on unit 8 except that the Angophora sp. is replaced by closely spaced swamp mahogany (Tristania suaveolens) 10-20 feet high.

(v) Gleyed soils with texture contrast

Two soils with moderately developed gley features and a sharp texture contrast at relatively shallow depth form this group. The surface horizons are 9 to 18 inches thick, rather organic, and have sandy to loamy texture. The underlying stiff plastic clays are coarsely mottled and have strongly developed coarse prismatic structure with grey or bluish coatings on the prism faces. In some profiles of Beerwah 7 there is an indefinite A_{2g} horizon but this has not been observed in Beerwah 10 soils.

On morphological features Beerwah 7 is closely related to the poorly drained members of the Australian group of meadow podzolic soils (Stephens, 1956) although it appears to be more strongly gleyed and lacks the typical A_2 horizon development of the nodal members of this group. Beerwah 10 is more closely related to the provisional American group of humic gley soils (Thorp and Smith, 1949) but its surface (7 to 11 inches thick) may be too low in organic content for this group. Both the thickness of the A_1 horizon and the sharp texture contrast near the surface apparently preclude its inclusion in the low humic gley group (Thorp and Smith, 1949).

These soils are probably best placed as intergrades between the meadow podzolic and humic gley soils. In the Beerwah area they are small in extent and are associated with poorly drained marshy spots on the middle and lower slopes.

Beerwah 7 (loamy sand).— This soil has a very dark brownish grey loamy sand surface with organic matter accumulation and pronounced rusty brown root marking. Below about 5 inches the organic matter decreases, the rusty brown root marking becomes more frequent, and in some profiles there is a gradual change to an indefinite bleached A_{2g} horizon 2-3 inches thick immediately above the clay. At about 18 inches there is a sharp texture change to mottled yellow-brown and grey stiff heavy clay with strongly developed prismatic structure. Grey and light grey coatings are prominent on the prism faces. In this horizon root markings are rusty brown within aggregates and light grey-brown on the faces. Below 27 inches the soil is mostly mottled very light grey and yellow-brown heavy clay of coarse prismatic structure grading with depth into creamy white heavy clay with ochreous mottling.

This soil is found along the middle northern boundary of the area on a gently sloping site carrying scattered broad-leaf tea-tree, numerous stunted Hakea gibbosa, fine leaf Banksia sp., Callistemon pachyphyllus, Leptospermum sp. and a dense cyperaceous ground cover. The area is poorly drained to marshy with very slow surface drainage under natural conditions, and internal drainage is impeded by the clay.

Beerwah 10 (loam).— This soil is distinguished from Beerwah 7 by its heavier surface texture, shallow depth (7 to 11 inches) to B_2 horizon, and absence of A_{2g} horizon.

The surface 7 to 11 inches is a dark brownish grey loam to clay loam, rather organic and sandy, with rusty yellow-brown spots and some dark rusty root-markings. Below this is a sharp change to a mottled yellow brown and yellow grey heavy clay with strongly developed prismatic structure. The prism surfaces have strong grey and light grey coatings crossed by light grey-brown root tracings. With depth the soil grades into slightly mottled white stiff heavy clay with some coarse prismatic structure.

Beerwah 10 is very limited in extent occurring only in one area as small patches a few yards across, forming a complex with units 4 and 5. It occurs on the mid-slope sites occupying small marshy spots with slow surface drainage and strongly impeded internal drainage, often

being saturated above the clay during wet periods.

In the survey area this soil has been cultivated but the native vegetation is believed to have been very similar to that on unit 7. Following cultivation Schoenus sp., Juncus sp. and Cyperus sp. have regenerated.

(vi) Ground water podzols

Soils with the morphological features of the ground water podzols (Stephens 1956) occupy a very small area marginal to a minor drainage line. Characteristic features are organic sandy surface horizons speckled with white sand grains, well defined sandy A_2 horizons and cemented organic pan B_2 horizons grading below into lumpy organic stained B_3 horizons. At depth there is a very light grey prismatic, heavy clay which is regarded as a D horizon with respect to the developed soils.

Beerwah 11 (Organic sandy loam).— This soil has about 13 inches of dark organic loamy sand surface of loose consistence grading into a white sand A_2 horizon 9 inches thick. Below 22 inches there is a gradual change to a patchy light grey-brown organic-stained sand B_1 horizon grading with depth into very dark brown, massive, organic pan below about 30 inches. With depth the colour lightens and the pan gives way to large organic-stained cemented lumps. This horizon often contains free water and is underlain below 48 inches by a light grey stiff-plastic clay.

Surface drainage under natural conditions is slow and internal drainage is strongly impeded. From observations during the survey it seems likely that the B_3 horizon is saturated throughout most of the year and that water is perched temporarily on the organic pan during wet periods.

Cultivation has destroyed the native vegetation. The few remaining plants suggest that the soil supported a heath-like vegetation including Dillwynia sp., Aotus sp., Leucopogon sp., Sowerbaea sp. and Xanthorrhoea sp.

Beerwah 12 (Organic Loamy sand).— Beerwah 12 is distinguished from Beerwah 11. by an A_1 horizon of raw organic matter a somewhat indefinite A_2 horizon, and shallow depth to the organic pan. The surface 4 inches consists of very dark grey-brown raw organic matter strongly speckled with white sand grains grading into about 6 inches of organic loamy sand. Below 10 inches there is a gradual change to an indefinite A_2 horizon of brownish grey sand which is underlain at 16 inches by a very dark reddish brown, massive, organic pan. At 30 inches there is a gradual change to large whitish cemented sandy lumps with some organic staining. This layer contains free water and is underlain below 50 inches by whitish heavy clay coarsely mottled with brownish yellow.

Drainage is as for unit 11 and the vegetation appears to have been similar but denser.

(c) Topographic and drainage relationships of the soils.

In this area of high rainfall and relatively uniform parent materials the most striking differences between soils show strong correlation with differences in drainage status of the units. These drainage differences are due to the combined effect of topographic position, surface slopes, and the relative permeability of the various horizons of the profiles.

Soil boundaries broadly follow the contour pattern except where wet conditions are localised in some mid slope positions owing to minor irregularities in slope and the pattern of parent materials. Generally the nodular podzolic soils occupy the higher and more sloping sites where drainage is relatively free and the humic gleys are restricted to the poorly-drained depressions. Between these extremes the degree of development of gley features reflects the intensity of drainage impedance. The normal topographic sequence (see Figs. 1 and 2) is from nodular podzolics, Beerwah 1, 2 and 3, on the higher slopes, through the gleyed podzolics Beerwah 4 and 5 in mid-slope positions and on low saddles, to the low humic gley, Beerwah 6, on lower slopes and the humic gleys Beerwah 8 and 9 in the marshy drainage depressions. In places some of these units occur only as narrow more or less transitional belts across slopes.

The ground water podzols and gleyed soils with texture contrast do not form part of the general pattern, and are both limited to single occurrences in mid-slope positions. The former have developed in colluvial accumulations of sand overlying a clay (?) D horizon of low permeability. This layer has restricted water movement resulting in saturation of the overlying sands during wet seasons. Downslope seepage to these areas probably maintains the perched free water table in them for long periods. In the gleyed soils with texture contrast clay subsoils of low permeability occur at shallow depth and the presence of Juncus species and other plants common to wet environments suggest that wet conditions in the A horizon continue for longer periods than in all but the poorly drained gley soils.

Accumulations of ferruginous nodules are limited to sandy horizons and the upper parts of underlying clay horizons of these soils in which frequent alternations of partial saturation and relative dryness are to be expected under present climatic conditions.

(d) Soil Factors Affecting Use

The principal factors limiting the potential of the Beerwah soils for more intensive use under pastures or fodder crops are their poor moisture relationships and their well-known low nutrient status.

Despite the high mean annual rainfall of the area there is great variation in the annual totals, seasonal distribution and in the amount and intensity of individual falls. These conditions coupled with the low field capacities of the sandy horizons and wide ranges of slope, topographic position and depth to clay subsoils, produce a great range of soil moisture conditions within the area. Although differences in the

moisture regimes of the soil types create problems in their management for plant production, the range of conditions within the landscape as a whole may well be an advantage if the country is developed. It should ensure a more even spread of pasture production throughout the year if holdings include the full range of soils from ridge crests to drainage depressions.

In years of well distributed high rainfall, the best-drained soils with deep sandy A horizons (Beerwah 1 and 2) should provide the most suitable moisture conditions for plant growth. When rainfall is low with a poor distribution of falls, the gley soils (Beerwah 6, 8 and 9) of the lower sites would be expected to provide the longest period of suitable soil moisture conditions and the freely drained deep sandy soils will often be droughty.

For development to sown pastures or crops the gley soils - Beerwah 6, 8 and 9 - will require some drainage in all but relatively dry years. While this must be effective enough to prevent serious water-logging during wet periods, over-drainage should be avoided for it might well leave the soils too dry for plant growth toward the end of the wet season when temperature conditions are still suitable. Controlled drainage by suitable checks along main drains to limit lowering of the water table during very dry periods should be an important factor in getting maximum production from these soils. Some temporary drains from areas of gleyed soils on higher sites will also be necessary in wet years.

The nutrient status of some soils of the coastal lowlands have been discussed previously (Hubble, 1954) in general terms on the basis of laboratory data and knowledge of similar soils from southern Australia. Two of the profiles studied are from the Beerwah area - B 184 representing Beerwah 6 and B 183 which is closely related to Beerwah 5. Data for these and other nodular podzolic soils from the coastal lowlands (Coaldrake: in press) indicate low to very low contents of phosphorus, nitrogen, potassium and calcium. Severe to moderate deficiencies of these elements for growth of pasture and crop plants are certain in all of the sandy soils of the area.

Detailed studies of the nutrient status of Beerwah soils by pot and field experiments are being made by the C.S.I.R.O. Division of Plant Industry. Results of this work on Beerwah 6 soil reported by Andrew and Bryan (1955) show that heavy applications of phosphatic fertilizers are necessary for good plant growth and that significant responses have followed applications of calcium, potassium, copper, zinc and nitrogen. A slight response to molybdenum fertilization has also been obtained. Similar deficiencies of greater or less severity can be expected with all of the sandy Beerwah soils. Losses of soluble nutrients by leaching during periods of heavy rain are to be expected on the sandy soil. This should be borne in mind when considering maintenance fertiliser application following development of the area.

IV. ACKNOWLEDGEMENT

Acknowledgements are due to the Agronomy Section C.S.I.R.O., Division of Plant Industry, for the ~~contour~~ base map on which the soils are plotted and for the pegging of base lines and provision of labour in the field; to Dr. S.T. Blake (Botanist, Queensland Herbarium) for identification of plant specimens; and to Mr. G.D. Hubble, C.S.I.R.O. Division of Soils, for discussion of the soils and their classification in the field and for constructive criticism during the preparation of this report.

V. REFERENCES

- Andrew, C.S. and Bryan W.W. (1955).-- Pasture studies in the coastal lowlands of sub-tropical Queensland.
Aust. J. Agric. Res. 6: 265-298.
- Coaldrake, J.E. - The ecosystem of the Coastal Lowlands of southern Queensland. (Papers in preparation).
- Coaldrake, J.E. and Bryan W.W. (1957).-- A rainfall map of south-eastern Queensland.
C.S.I.R.O. Aust. Div. P.I. Techn. Pap. No. 8.
- Hubble, G.D. (1954).-- Some soils of the Coastal Lowlands, north of Brisbane, Queensland.
C.S.I.R.O. Aust. Div. Soils. Div. Rep. 1/54.
- Stephens, C.G. (1956).-- A manual of Australian soils.
(C.S.I.R.O., Melbourne, Australia.)
- Thorp, J. and Smith, G.D. (1949).-- Higher categories of soil classification: order, sub-order and great soil group.
Soil Sci. 67: 117-126.

APPENDIX 1

SOIL TYPE DESCRIPTIONS

BEERWAH 1

	<u>Depth in Inches</u>	<u>Descriptions</u>
A ₁	0	<u>Dark brownish grey (m*. 10YR 4/1) loamy sand, much speckling, very weak crumb structure, loose when dry and extremely friable when moist. Grading into:</u>
A ₂	5 { 6	<u>Light yellow-brown(2.5Y 8/5)loamy sand, structureless, extremely friable when moist, small amounts of soft 1/2-1 inch nodules. Changing gradually to:</u>
B ₁	16 { 20	<u>Light yellow-brown (2.5Y 8/5) sandy loam, becoming yellow-brown (m. 10YR 7/8) with depth, massive structureless in place, very friable when moist, small amounts of soft 1/2-1 inch nodules. Changing slowly to:</u>
B ₂	42 { 45	<u>Yellow-brown (m. 10YR 7/8) sandy clay loam - sandy clay, with some red-brown mottling, massive to weak blocky structure, large amounts of soft 1/2-1 inch nodules. Grading into:</u>
B ₃	56 { 82	<u>Red (m. 1YR 4/8) heavy clay with coarse yellow-brown and light grey mottling, stiff-plastic when wet, some soft 1/4-1 inch nodules.</u> Maximum.

* Munsell soil colour notations marked thus, "m", are for moist or wet soil; all others are for air-dry soil.

BEERWAH 2

	<u>Depth</u> <u>in</u> <u>Inches</u>	<u>Description</u>
A ₁	0	<u>Brownish grey (m. 10YR 5/1) loamy sand, much white speckling and some yellowish grey patches, very weak coarse crumb structure, very friable when moist and weakly coherent when dry. Grading into:</u>
A ₂	5 { 2 6	<u>Light yellow-grey (m. 2.5Y 8/6) loamy sand, with brownish grey and light yellow-brown patches, structureless, loose when dry and extremely friable when moist. Changing gradually to:</u>
B ₁	12 { 9 16	<u>Faintly mottled yellow-brown (m. 10YR 7/8) sandy clay loam, massive to weak blocky structure, very friable when moist, small amounts of soft $\frac{1}{4}$-$\frac{1}{2}$ inch nodules, few pieces $\frac{1}{2}$ inch silica gravel. Changing slowly to:</u>
B ₂	27 { 24 33	<u>Yellow-brown (m. 10YR 7/8) sandy medium clay mottled with red (m. 2.5YR 4/8) and some yellow-grey, massive to weak blocky structure, friable to firm when moist, moderate amounts of $\frac{1}{2}$-2 inch soft nodules mostly in red mottle, some fine silica gravel. The upper part of this horizon is dominantly yellow-brown, the red mottle increasing with depth. Grading into:</u>
B-C	40 { 36 45	<u>Coarsely mottled red (m. 1.5YR 4/8), and very light bluish grey (m. 2.5Y 7/1) heavy clay with some yellow-brown patches, massive and stiff-plastic when wet, few fine nodules in red mottle, some fine silica gravel. Changing gradually to:</u>
B-C	66 { 54 <72	<u>Very light grey heavy clay coarsely mottled with red, dark red and bright yellow, stiff-plastic when wet, some fine silica gravel.</u>
	84	Maximum.

BEERWAH 3

	<u>Depth in Inches</u>	<u>Description</u>
A ₁	0	<u>Brownish grey (m. 10YR 4.5/1) loamy sand</u> , with few yellowish grey patches, weak fine blocky structure, friable when moist, some coarse sand and fine gravel. Grading into:
A ₂	5 { 3 6	<u>Very light yellow-grey (m. 5Y 7/2.5) sand to loamy sand</u> , with faint brownish grey and yellow-brown mottling, structureless, very friable when moist, some coarse sand and fine gravel, few rusty brown concretions and $\frac{1}{4}$ inch nodules in some profiles. Changing fairly quickly to:
B ₁	10 { 8 12	<u>Light yellow-brown (m. 10YR 7.5/8) sandy clay loam</u> , weak coarse blocky structure, friable when moist, some coarse sand and fine gravel, moderate amounts of nodules. Changing slowly to:
B _{2₁}	16 { 9 19	<u>Yellow-brown (m. 10YR 6.5/8) sandy clay or sandy medium clay</u> , some reddish brown mottling with depth, weak blocky structure, very firm when moist, very large amounts of $\frac{1}{2}$ -2 inch nodules, some silica gravel and coarse sand. Grading into:
B _{2₂}	24 { 17 (<u>Yellow-brown (m. 10YR 6/8) heavy clay with coarse red brown (m. 2.5YR 4/8) and yellow-grey mottling</u> , coarse blocky structure, firm when moist, moderate amounts of $\frac{1}{2}$ -2 inch nodules, some fine silica gravel. Changing to:
B-C	36 { 33 40	<u>Light grey (m. 2.5Y 7/2) heavy clay with coarse yellow-brown (m. 10YR 6/8) and red (m. 1.5YR 4/8) mottles</u> , very stiff-plastic when wet, trace silica gravel. Continuing with little colour variation to:
	82	Maximum.

BEERWAH 4

	<u>Depth</u> <u>in</u> <u>Inches</u>	<u>Description</u>
A ₁	0	Light brownish grey (m. 10YR 5/2) loamy sand, with much white speckling, weak blocky to crumb structure, extremely friable when moist, surface $\frac{1}{4}$ inch slightly compact. Grading into:
A _{2g}	5 { 8	Brownish white sand or loamy sand, faintly mottled with brownish grey and rusty yellow, structureless, extremely friable when moist, much rusty brown root markings. Changing over 1 inch to:
B _{21g}	10 { 13 { 16	Yellow-brown (m. 10YR 5/4) heavy clay often sandy, mottled with yellow-grey (m. 2.5Y 7/6), some reddish brown mottle with depth, strong prismatic to blocky structure with mottled light grey (m. 10YR 5/1) and rusty brown (m. 5YR 5/6) aggregate faces, very firm when moist, much rusty-brown root marking, trace of silica gravel. Changing gradually to:
B ₂₂	16 { 20 { 26	Mottled yellow-brown (m. 10YR 5/4) light grey (2.5Y 7/0) and red (m. 10R 3/6) heavy clay, weak coarse blocky structure, stiff plastic when wet, prominent rusty yellow root markings, trace of fine silica gravel, few soft nodules in the red mottle. Grading into:
B-C	30 { 33 { 36	Light grey (m. 2.5Y 7/0) heavy clay coarsely mottled with red (m. 7.5R 3/6) and some light brownish yellow, massive to weak coarse blocky structure, stiff plastic when wet, trace of silica gravel, few $\frac{1}{4}$ inch nodules in the red mottle. Changing gradually to:
C	50 { 66	Light grey heavy clay coarsely mottled with greenish white and red, massive and stiff-plastic when wet.
	84	Maximum.

BEERWAH 5

	<u>Depth in Inches</u>	<u>Description</u>
A ₁	0	<u>Dark brownish grey (m. 10YR 4/1) loamy sand, much white speckling of fine quartz sand, low amount of organic matter, weak fine blocky to crumb structure, extremely friable when moist, colour becoming very patchy with depth. Grading into:</u>
A _{2g}	9 { 7 13	<u>Very light yellow-grey (m. 5Y 7/2.5) sand, faintly mottled with white, brownish grey and yellow-brown, structureless in places, extremely friable when moist, prominent rusty yellow root markings. Changing slowly to:</u>
A _{3g}	16 { 14 18	<u>Light yellow-grey (m. 2.5Y 7/6) clayey sand or sandy loam, mottled with light yellow-brown (m. 10YR 8/8), massive to very weak prismatic structure, very friable when moist, prominent rusty yellow root markings. Changing gradually to:</u>
B _{2g}	21 { 17 25	<u>Light grey (m. 2.5Y 7/2) sandy clay loam to sandy clay with coarse yellow-brown (m. 10YR 7/8) and red-brown (2.5 YR 4/6) mottling, weak prismatic structure, very friable when moist, low to large amounts of large ½-3 inch nodules mostly associated with the red-brown mottle. Changing fairly quickly to:</u>
B-C	30 { 27 36	<u>Very light grey (m. 2.5Y 8/0) heavy clay with coarse yellow-brown (m. 10YR 7/8) and red (2.5YR 4/8) mottling, with sandy fill in structural crevices, massive to coarse prismatic structure. Stiff-plastic when wet, some small nodules in the brighter mottles. Grading into:</u>
B-C	46 { 42 57	<u>Very light grey (m. 2.5Y 8/0) heavy clay with coarse red (m. 2.5YR 4/8) mottles, massive and stiff-plastic when wet, few small nodules. Continuing with slight colour variation to:</u>
	82	<u>Maximum.</u>

HEERWAH 6

<u>Depth in Inches</u>		<u>Description</u>
A ₁ ₁	0	<u>Dark brownish grey (m. 10YR 7/1) organic loamy sand or loamy sand with organic matter, much white speckling with fine quartz sand, weak crumb to fine blocky structure, extremely friable when moist, very porous material with numerous fibrous roots mostly with dark rusty brown outlines. Grading into:</u>
A ₁ _{2g}	10 { 5 12	<u>Brownish grey (m. 10YR 4/1) sand to loamy sand with light grey and dark brownish grey patches and little organic matter, very weak 1/2 inch blocky units, extremely friable when moist, many roots with prominent rusty brown outlines. Changing fairly quickly to:</u>
A ₂ _{1g}	16 { 11 18	<u>White (m. 2.5YR 8/2) or very light brownish grey sand, some rusty yellow-brown inclusions, structureless in place, wet and friable, prominent rusty yellow root lines in the upper part of horizon, water table usually present in this layer. Changing gradually to:</u>
A ₂ _{2g}	18 { 15 20	<u>White (m. 2.5YR 8/2) clayey sand to sandy loam, some yellow-brown (m. 10YR 7/8) patches, structureless, extremely friable when moist, numerous rusty yellow root mottlings and trace of fine silica gravel. Changing quickly, sometimes abruptly to:</u>
B _{2g}	24 { 19 30	<u>Very light bluish grey (m. 5Y 8/1) sandy clay to sandy medium clay mottled with yellow-brown (m. 10YR 7/8), coarse blocky to prismatic structure, plastic when wet, prominent rusty yellow root markings.</u>
B _{2c} _g	33 { 27 39	<u>Very light bluish grey (m. 5Y 8/1) heavy clay with prominent coarse brownish yellow mottling, massive to coarse prismatic structure with brownish white sand veins between aggregates, stiff-plastic when wet, light grey-brown root markings, trace of fine silica gravel, some profiles have some reddish brown mottling in this horizon. Continuing with minor colour and texture differences to:</u>

HEERWAH 7

	<u>Depth in Inches</u>	<u>Description</u>
A ₁ 1g	0 {	<u>Very dark brownish grey loamy sand with organic matter</u> , often with a strong brownish tinge and rusty brown flecking, granular to $\frac{1}{4}$ inch blocky structure, friable when moist, strong rusty brown root marking. Grading into:
A ₁ 2g	4 {	<u>Dark brownish grey loamy sand with slight organic matter</u> , faint brownish grey patches and white speckling, very weak fine blocky structure, friable when moist, pronounced rusty brown root markings.
	5 {	
	8 {	
A ₂ g	11 {	<u>Mottled brownish white, yellow-grey and yellow-brown sand to sandy clay loam</u> , massive structureless in place, friable when moist, pronounced rusty root markings. An indefinite horizon not present in all profiles and often only 2 to 3 inches thick and weakly defined. Changing abruptly to:
	13 {	
	16 {	
B ₂ g	16 {	<u>Mottled light grey and yellow-brown stiff heavy clay</u> , some reddish brown mottling, well developed 3 to 4 inch prismatic structure with grey markings along aggregate faces, and rusty brown markings within aggregates. Changing slowly to:
	18 {	
	22 {	
B ₂ g	24 {	<u>Very light grey stiff heavy clay with ochreous red mottling</u> , massive to coarse prismatic structure, stiff-plastic when wet. Changing gradually to:
	27 {	
	32 {	
B ₀	42 {	<u>Very light grey (creamy when moist) stiff heavy clay</u> , with some ochreous mottling, stiff-plastic when wet. Continuing to:
	66	Maximum.

HEERWAH 8

<u>Depth in Inches</u>		<u>Description</u>
A ₁ ₁	0	<u>Very dark brownish grey (m. 10YR 2/1) organic sandy loam, much white speckling and some rusty brown root markings, fine blocky structure, friable when moist, very porous material. Grading into:</u>
A ₁ ₂	12 16 18	<u>Very dark brownish grey (m. 10YR 2/1) organic sandy loam or lighter with light brownish grey patches pronounced white speckling, some rusty brown root-markings, weak fine blocky structure, very friable when moist, very porous material. Changing fairly quickly over 2 inches to:</u>
A _{2g}	18 24 33	<u>Very light brownish grey drying white sand or loamy sand, bright rusty yellow-brown root markings and fine inclusions particularly in the upper part of the horizon, massive - structureless, very friable when moist, water table in this horizon usually below 24 inches. Changing abruptly to:</u>
G	32 39 48	<u>Very light grey (drying white) sandy medium to heavy clay, with some fine yellow-brown mottling, coarse prismatic structure, stiff-plastic when wet, sandy fill between structural units, some fine silica gravel, light grey-brown rootmarkings. Changing gradually to:</u>
G	48 51 66	<u>Very light grey (drying white) sandy heavy clay, with coarse orange-brown and brownish yellow mottling, ? coarse pseudo-prismatic structure, stiff-plastic when wet.</u>
	82	Maximum.

BEERWAH 9

<u>Depth in Inches</u>		<u>Description</u>
A ₁	0	<u>Very dark brownish grey (m. 10YR 2/1) organic loam,</u> speckled with white when dry, few rusty brown root markings, fine granular structure changing below 9 inches to strongly developed $\frac{1}{4}$ inch granular units, friable when moist. Grading through:
A ₁₂	24 { 27 30	<u>Patchy dark brownish grey (m. 10YR 3.5/1) and very</u> <u>light brownish grey (m. 10YR 7.5/1) organic sandy</u> <u>loam or loamy sand,</u> weak fine blocky structure, usually saturated in this horizon. Some rusty root markings. Changing fairly rapidly to:
A _{2g}	30 { 36 42	<u>Very light grey-brown (m. 10YR 8/1.5) (drying white</u> <u>sand or clayey sand,</u> some pale yellow mottles, structureless, saturated for much of the year, may contain some soft organic and/or iron cemented nodules 2-3 inch size, trace of fine silica gravel. Changing abruptly to:
G	45 { 54	<u>Very light bluish grey (drying white) sandy medium</u> <u>to heavy clay,</u> with faint bluish, greenish and yellowish $\frac{1}{2}$ -1 inch patches, coarse "pseudo-prismatic" structure with sandy fill between units, stiff-plastic when wet, some silica gravel and in some profiles 1-2 inch hardened iron and/or organic lumps. Grading into stiff plastic heavy clay with little sand with depth.
	82	Maximum.

BEERWAH 10

<u>Depth</u> <u>in</u> <u>Inches</u>		<u>Description</u>
A _{1g}	0	<u>Dark brownish grey (m. 10YR 3/1) loam to clay loam rather organic and sandy, many small rusty yellow brown spots and some white speckling, fine irregular blocky structure, friable when moist. Changing abruptly to:</u>
B _{2g}	9 { 7 11	<u>Mottled yellow-brown (m. 10YR 6/6) and light yellow-grey (m. 2.5Y 8/6) heavy clay, with dark bluish grey (m. 2.5Y 4/0) and light grey stained aggregate surfaces, some rusty brown rootmarkings and many light grey-brown root channels, strong coarse prismatic structure, stiff-plastic when wet. Grading into:</u>
B _{31g}	27 { 24 30	<u>Very light brownish grey (m. 10YR 5/2) drying white heavy clay, with some yellow-brown mottling (m. 10YR 7/8), coarse blocky structure, stiff-plastic when wet, trace of fine silica gravel, many light grey-brown root channels, few rusty brown root markings. Changing gradually to:</u>
B _{32g}	72 { 66 75	<u>Very light grey to white (m. 10YR 8/1) sandy heavy clay, with few coarse yellow-brown and red mottles and some bluish and greenish patches, some sandy patches along cleavage lines, trace silica gravel. Continuing to:</u>
	82	Maximum.

PETERWAH 11

	<u>Depth in Inches</u>	<u>Description</u>
A ₁	0	<u>Very dark brownish grey (m. 10YR 2/1) organic loamy sand, with much white speckling, weak crumb to granular structure, very friable when moist, some light brownish grey patches with depth. Grading into:</u>
A ₂	13 { 10 19	<u>Very light yellowish grey or white sand, massive and structureless in place, soft when wet, weakly coherent when dry. Changing fairly quickly to:</u>
B ₁	22 { 22 30	<u>Patchy dark brownish grey (m. 10YR 3/1) and light grey-brown organic sand, texture and dark colour increasing with depth, massive in place, friable to firm when wet. Grading into:</u>
B ₂	30 { 27 36	<u>Mottled dark grey and dark brown organic pan, generally massive and hard in most profiles, lumpy in others. Grading through large organic stained lumps to:</u>
Dg	{ 48 {	<u>Light grey heavy clay, with brown and reddish brown mottling and greenish patches, stiff-plastic when wet, some sandy fill in crevices.</u> Water-table above this horizon.
	72	Maximum.

BEERWAH 12

<u>Depth in Inches</u>	<u>Description</u>
A ₀	Four to six inches of very dark grey-brown (m. 10YR 2/1.5) raw organic matter, much white white sand speckling when dry, fine crumb structure, friable when moist. Grading into:
A ₁ 0	Very dark brownish grey (m. 10YR 2/1) organic loamy sand or lighter, much white speckling, weak blocky structure, extremely friable when moist. Changing to:
A ₂ 6	Brownish grey sand, with darker patches and much white speckling, massive structureless, extremely friable when moist. Changing fairly rapidly to:
B ₂ 12	Very dark reddish brown (m. 5YR 3/3, 2/2) or very dark grey (m. 10YR 2.5/1) organic pan, organic loamy sand texture becoming lighter with depth, massive structure, very hard when dry, with depth the pan is mostly brown (m. 8.5YR 5/6) and may be massive or lumpy. Grading into:
B ₃ 26	Mottled white and yellow-grey pan, with brown organic staining, sometimes massive structure but generally lumpy units 6 to 12 inches across, very hard when dry. Water-table in this horizon when examined. Changing to:
Dg 48	White heavy clay, with coarse brownish yellow and brown mottling decreasing with depth, massive and stiff-plastic when wet. Continuing to:
78	Maximum.

SOIL MAP OF THE BEERWAH EXPERIMENTAL AREA, PARISH OF BRIBIE, COUNTY OF CANNING, S.E. QUEENSLAND

SCALE

CHAINS

K E Y

SOIL UNITS OF THE BEERWAH AREA

Mapping Unit	Distinctive Features	Great Soil Group
Beerwah 1	Thick yellow-brown sandy loam B ₁ horizon, yellow-brown mottled with red sandy clay B ₂ horizon coarsely mottled heavy clay below 5 feet.	Lateritic podzolic soils (Stephens, 1956)
Beerwah 2	Yellow brown sandy clay loam B ₁ at 12 inches, yellow-brown mottled with red sandy clay B ₂ at 27 inches, coarse mottled heavy clay below 40 inches.	
Beerwah 2 coarse sandy varient	As for Beerwah 2 but with brighter coloured B ₁ and high coarse sand component.	
Beerwah 3	16 inches to yellow-brown sandy to medium clay B ₂ , coarse mottled heavy clay below 36 inches. A ₂ more definite, much higher coarse sand component and larger amounts of nodules than above soils.	Coarse textured soils essentially podzolic in character, underlain at depth by mottled kaolinitic clays. Horizon boundaries are diffuse and the A ₂ horizons are usually feebly defined. Ferruginous nodules of varying size occur in the lower A, B and B-C horizons often with heavy accumulations in the B ₁ and upper part of the B ₂ .
Beerwah 4	Sandy surface, bleached A ₂ horizon with rusty root-markings, a sharp change to prismatic clay at 13 inches, coarse mottled heavy clay below 33 inches.	
Beerwah 5	About 9 inches of dark surface, very light yellow-grey A ₂ with gley features, coarsely mottled sandy clay with large nodules below 21 inches, coarsely mottled heavy clay below 30 inches.	
		Meadow podzolic soils (Stephens, 1956)
		Imperfectly drained soils with coarse textured surfaces darkened by organic matter, bleached A ₂ horizons, and a sharp change to fine textured, coarse structured B ₂ horizons. Gley features in A ₂ and B ₂ horizons.

Mapping Unit	Distinctive Features	Great Soil Group
Beerwah 5 coarse sandy variant	As for Beerwah 5 but with high coarse sand component.	
Beerwah 7	A dark somewhat organic surface, a thin indefinite A_2 sharp change to mottled yellow-brown prismatic clay at 18 inches grading into creamy heavy clay with depth.	Related to meadow podzolics (see above) but with strongly gleyed features and by comparison feeble A_2 horizon.
Beerwah 10	Similar to 7 but with somewhat organic loam surface, no A_2 horizon, and sharp change to prismatic clay at 9 inches.	Related to humic gleys (see below) but less organic and with sharp texture change at shallow depth.
Beerwah 6	Thin to moderately thick surface of low organic content, pronounced bleached A_2 with gley features. Water table above whitish prismatic clay at 24 inches.	Low humic gley (Thorp and Smith 1949). Poorly drained soils with thin organic surface horizons over gleyed mineral horizons with low degree of texture differentiation.
Beerwah 8	Very thick, organic, sandy loam surface horizons, bleached A_2 sand horizons with gley features, water-tables above gleyed "pseudo-prismatic" clay horizon at 40 inches.	Humic gley soils (Thorp & Smith, 1949). Poorly drained hydromorphic soils with moderately thick organic-mineral horizons underlain by mineral gley horizons.
Beerwah 9	Very thick organic loam going to sandy loam surface horizon, bleached A_2 horizon with gley features, water-table above gleyed "pseudo-prismatic" clay at 4 feet)	
Beerwah 11	About 12 inches of organic sandy surface soil. Strongly bleached A_2 horizon, massive dark organic pan at 30 inches underlain by white heavy clay at 4 ft,	Ground water podzols (Stephens, 1956). Sandy soils with dark grey surface horizons, pronounced A_2 horizons, and underlain by dark massive organic-cemented pans.
Beerwah 12	Raw organic matter A_0 horizon, organic loamy sand A_1 and indefinite A_2 horizon, thick dark massive organic pan at 16 inches underlain by white heavy clay below 4 feet.	

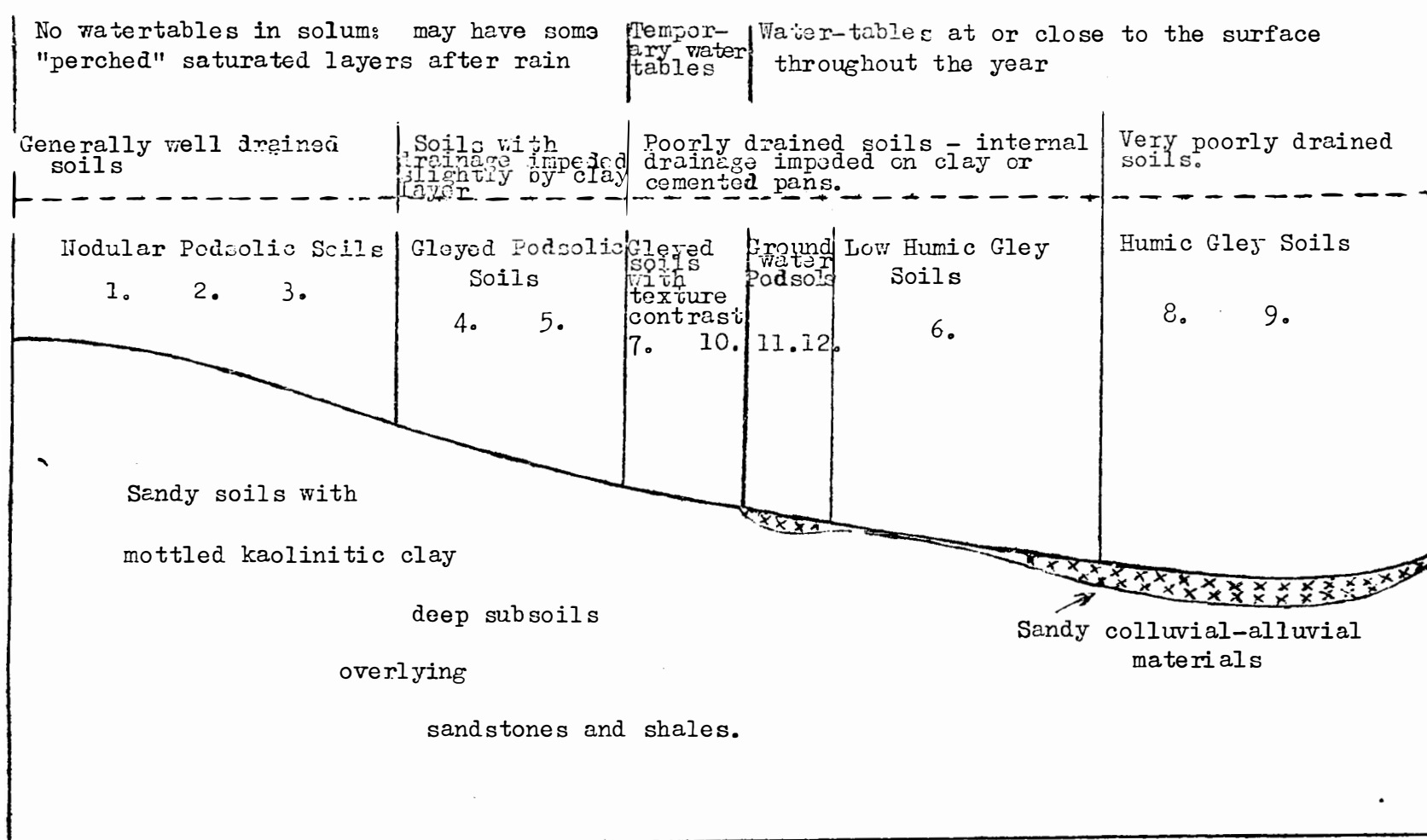


Figure 1. Schematic cross-section showing topographic occurrence, relationship, and drainage status of the Beerwah soils.

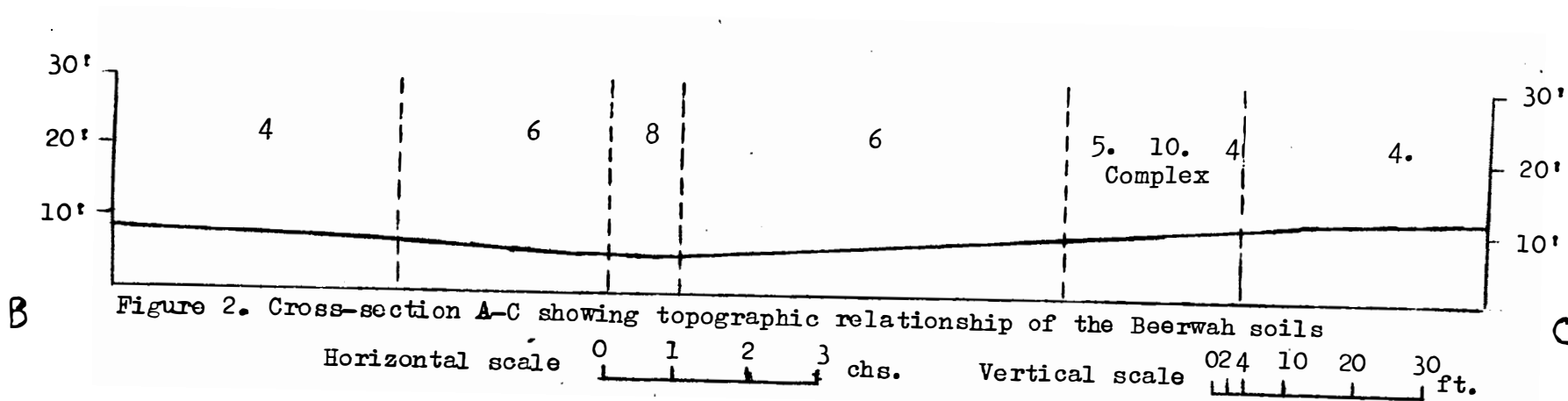
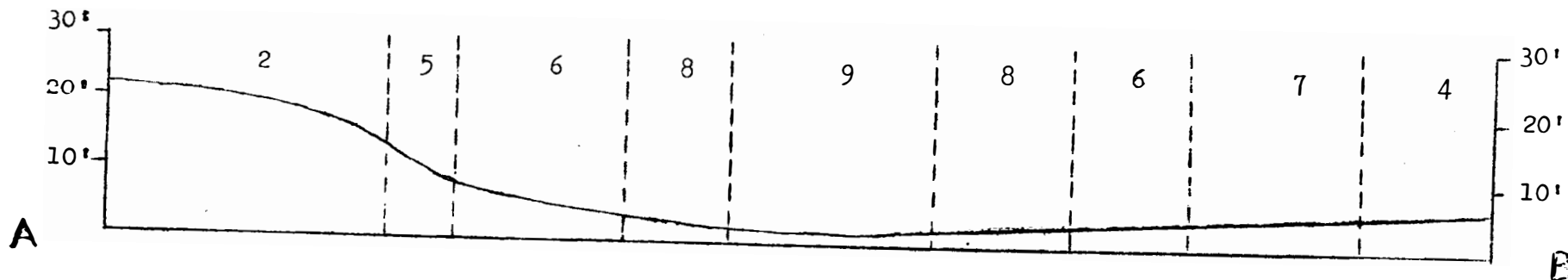


Figure 2. Cross-section A-C showing topographic relationship of the Beerwah soils

Horizontal scale 0 1 2 3 chs.

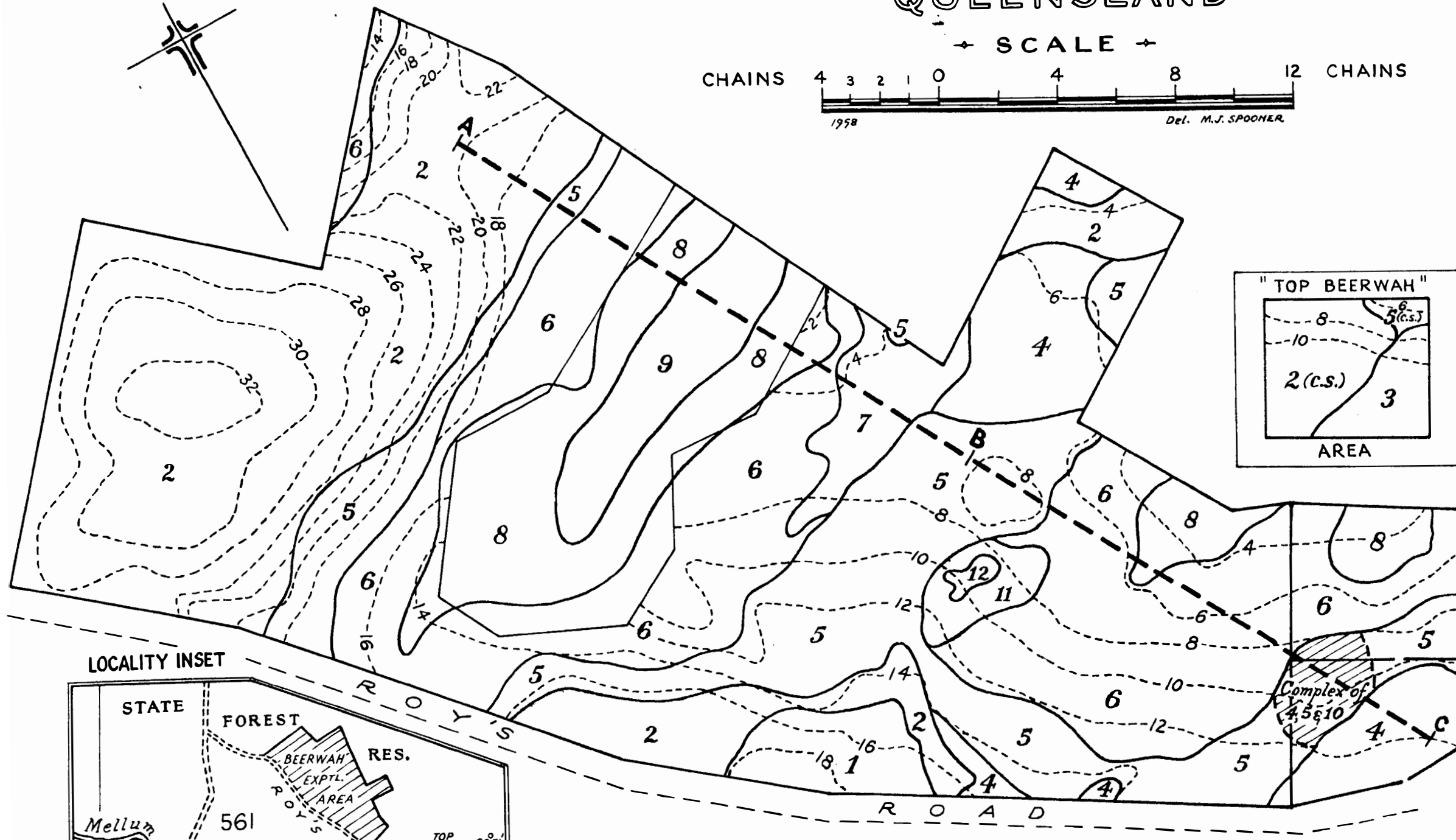
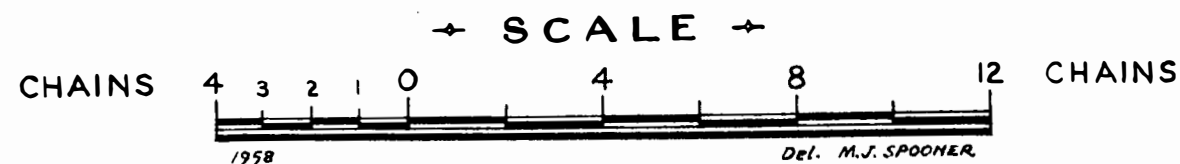
Vertical scale 0 2 4 10 20 30 ft.

SOIL MAP

C.S.I.R.O. EXPERIMENTAL AREA — BEERWAH

PARISH OF BRIBIE — COUNTY OF CANNING

QUEENSLAND



KEY TO SOILS

- 1 BEERWAH 1.
- 2 BEERWAH 2.
- 2(c.s.) BEERWAH Coarse Sandy Variant
- 3 BEERWAH 3.
- 4 BEERWAH 4.
- 5 BEERWAH 5.
- 5(c.s.) BEERWAH Coarse Sandy Variant
- 6 BEERWAH 6.
- 7 BEERWAH 7.
- 8 BEERWAH 8.
- 9 BEERWAH 9.
- 10 BEERWAH 10.
- 11 BEERWAH 11.
- 12 BEERWAH 12.

CONTOURS (approx.) at 2 Ft. intervals

CROSS SECTION A — B — C

SOIL SURVEYOR
C.H. Thompson
1956.