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LAND SUITABILITY ASSESSMENT AND SOILS OF THE CALLIOPE AND YEPPOON AREAS, QUEENSLAND

D.J. ROSS
RESOURCE MANAGEMENT

Department of Natural Resources,
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Summary

The survey area is situated around the towns of Calliope and Yeppoon on the Central Queensland Coast. It covers some 51 200 ha of uniformly flat to steep hilly topography. The major landforms are steep low hills and narrow valley floors. River terraces, beach ridges and tidal flats are minor in extent. Sedimentary, volcanic and granitic rocks are present.

Grazing beef cattle on native pasture is the dominant land use throughout the Capricornia coast. Suitable coastal land for horticultural use is characteristically scattered in distribution but comprises major production areas for pineapples, papaws, mangoes and other tropical fruits. Lychee, longan and custard apples are crops gaining popularity in coastal districts. Constraints to coastal broadacre horticultural expansion include landform, water supply, soils and frost.

The climate is tropical with moist hot summers and dry relatively short mild winters. Compared to inland areas of Central Queensland the warmer climate favours a wide range of both tropical and temperate crops. Production versatility is emphasised in appropriate climatic zones. Early market windows can be supplied without significant competition from other regions.

A land resource survey has been undertaken to identify lands suitable for horticultural production and to provide better soil information for management and planning purposes. This report describes the land resource and land suitability data for various classes of land. Important limitations to built infrastructure are described. The distribution of soils and land suitability classes are shown on accompanying maps. A local land suitability framework for land assessment for horticulture and data for 40 soil profiles are appended.

Ninety-three soils were recognised throughout the survey area. Soils with uniform, gradational and texture contrast profiles occur. Several have high exchangeable sodium and magnesium in their subsoil, and most have low fertility and low nutrient retention characteristics. The most versatile horticultural soils are deep and well drained, red in colour, low in fertility, and clay loamy to clayey in texture with a high water holding capacity.

A total of 1260 unique map areas were delineated. Each has been assessed for its suitability for the production of plantation, tree and vine crops. The survey area has been categorised and mapped according to its cropping versatility. Eight categories of suitable or marginal cropping land were identified in the Calliope area. Only 8.8%, or 2397.5 ha, of the Calliope area has been assessed as suitable land for plantation, tree and vine crops.

The Yeppoon area experiences higher rainfall and encompasses two different climatic zones. Fourteen categories of suitable or marginal cropping land were identified in this area. About 18%, or 4417.6 ha of the Yeppoon area was assessed as suitable land for plantation, tree and vine crops. Adequate land exists particularly in the Yeppoon area to enable a substantial increase in horticultural production over current use.

1. Introduction

Tropical coastal land with relatively short mild winters is important for horticultural production because of its ability to support a wide range of both tropical and temperate crops compared to inland areas, and southern states. The warmer climate permits greater flexibility in planting dates, an extended growing season and consequent market opportunities. In central Queensland, suitable coastal land is characteristically scattered in distribution, but comprises major production areas for pineapples, papaws, mangoes and other tropical fruits.

Previous surveys covering the Capricornia Coast were largely broad scale and appropriate only for regional inventory and planning purposes. Land use and land attributes were mapped as land classes (Gillies 1978) as land systems (Forster and Barton 1995) and as associations of soils (Isbell *et al.* 1967).

A land resource survey to assess the horticultural potential of selected areas along the central Queensland coast, and to provide better soil information for management and planning purposes, was initiated by the Queensland Department of Primary Industries in 1994 and completed by the newly formed Department of Natural Resources. The selected areas are situated around the coastal towns of Calliope and Yeppoon (Figure 1). These areas contain some horticultural activities and are experiencing pressure for land use change from predominantly rural to semi-rural, urban or industrial uses. The availability of good quality agricultural land suitable for horticulture in Calliope and Livingstone Shires is limited, and there is increasing pressure for rural-residential and urban expansion onto this land.

Sixteen areas covering approximately 51 200 ha in total, selected in consultation with planning officers from Calliope and Livingstone Shire Councils, were mapped at scales ranging from 1:25 000 to 1:55 000. Nine of these areas have appeared as interim reports (Ross 1996a-g, 1977a,b). This report and accompanying maps (1:75 000 scale) are a compilation of the sixteen selected areas. Descriptions of horticultural crop limitations, suitability of land for specific horticultural crops, built infrastructure limitations and soils are presented in this report.

The land resource data for the survey area are stored on computer files and the availability of this data can be obtained by contacting the Natural Resource Information Management Officer, Department of Natural Resources, 212 Quay Street, Rockhampton QLD. 4700. These files contain data for 1444 sites and data for 1260 UMAs (unique map areas).

Each mapped area is given a sequential number and called a unique map area, abbreviated to UMA. The site description file comprises descriptions of landform, vegetation and soil properties. The UMA data file contains land resource and interpreted information for each mapped area. The land resource attributes are landform, soils, lithology, slope, land degradation, cleared land, vegetation and land use. Interpreted information for each UMA are the suitability and limitations to vegetable crop, plantation, tree and vine crop and sown pasture production. The agricultural land class allocated to each UMA follows the four class system used in Queensland (Anon 1993). The UMA data can be manipulated using a Geographic Information System (ARCINFO software) to produce maps of any desired attribute or combination of attributes.

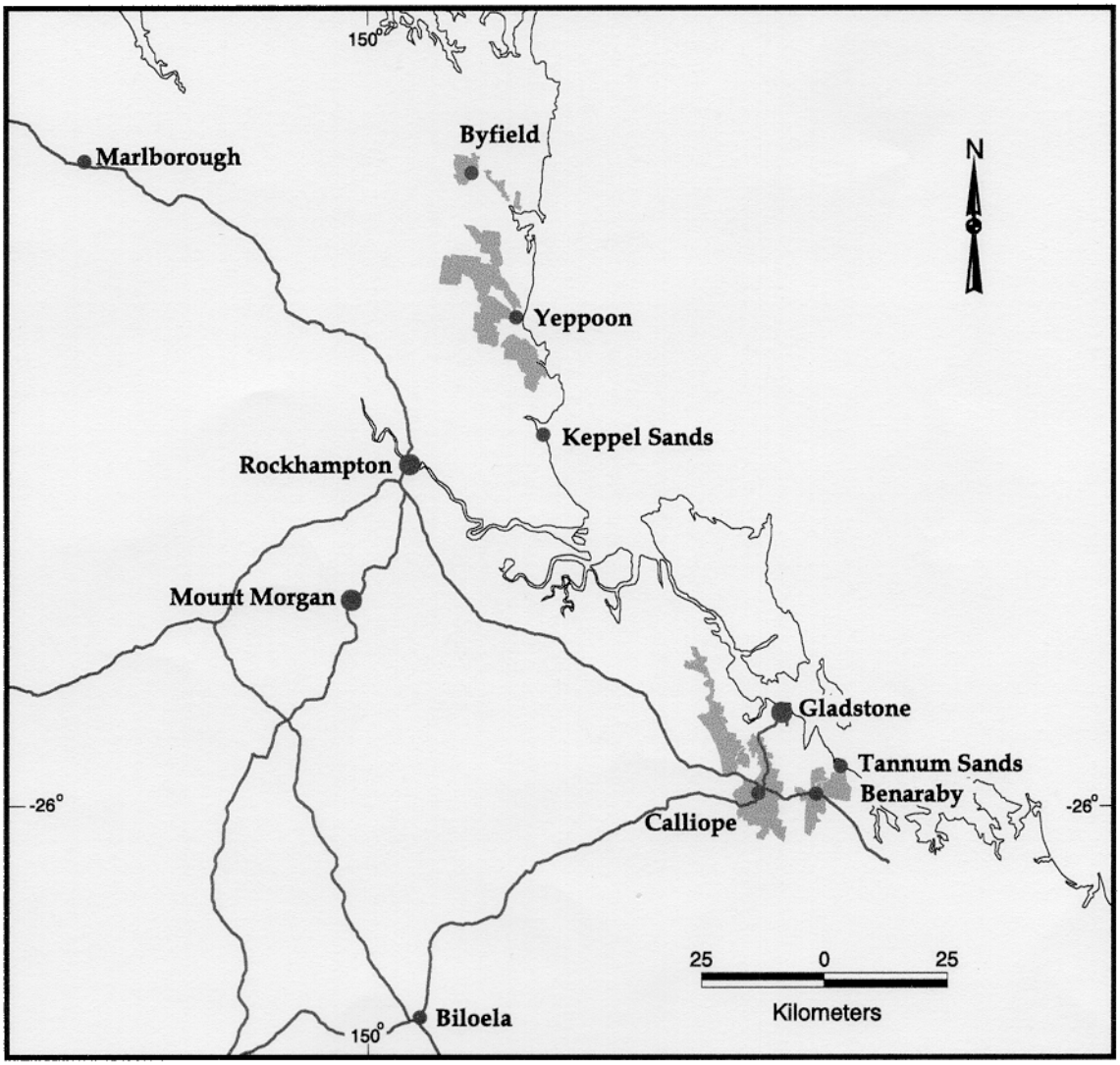

Figure 1. Location of survey areas

2. Land use

Grazing beef cattle on native pasture is the dominant land use throughout the Capricornia coast with stocking rates ranging from 1AE/20ha to 1AE/2-3ha depending on land type. Sown pastures are generally restricted to the higher rainfall zone north of Yeppoon. Pondage banks on plains provide green feed during the dry winter months. Mixed enterprises of grazing and horticulture occur on some properties. Compared with grazing horticulture is a minor land use. Constraints to coastal broadacre horticultural expansion include landform, water supply, soils and frost.

Horticultural production estimates for specific crops within the central Queensland region have been compiled by Macleod and Higham (1993) and updated by Garner (1995). The gross value of current horticultural production shows an increase to an estimated $ 50m (W N B Macleod *pers. comm.*). The coastal section from Byfield to Keppel Sands and Targinie to Benaraby is currently estimated to be some $ 11m per annum.

Some areas such as Byfield (Carpenter 1991), and Yarwun (McDonald 1988), have a long history of horticultural use. Cropping was initially established on steep land but was later found to be unable to sustain production through erosion and fertility decline. Mechanisation made steep slopes uneconomic. Pineapple production on steep land near Yeppoon has a similar cropping history. Current production in these areas mostly occurs on gently sloping land which can be cultivated for cropping.

Pineapples, mangoes, papaws and citrus are the major crops produced in the survey area. Minor crops are lychee, longan, custard apple, macadamia and cucurbits. Some avocado, banana, grape, stonefruit, fig, persimmon, black sapote, passionfruit, pecan and carambola are also grown.

Pineapple is the major crop grown and has been since the early 1950's. Production occurs in the Yeppoon district only. Although a decline in total production area and number of farms has occurred, production value is currently estimated at $ 4m per annum. Yeppoon is the most northern production area for the Golden Circle Cannery in Brisbane and as such has a four week earlier summer supply window over southern growing areas. Fresh fruit is supplied to all states, and the early harvesting feature favours this market also. Smooth Cayenne is the major variety grown which is suitable for both the fresh and processing market. Approximately 75% of fruit from the region is shipped to the Golden Circle Cannery.

A report of the physical and chemical properties of a range of soils used for pineapple production in the Yeppoon area, and a map showing production areas have been compiled by Powell (1977). Current yields under dryland conditions on the deep red soils Elizabeth and Lizard (see Section 5) are 70 to 85 t/ha for plant and 55 t/ha for ratoon crops. With selected watering plant crop yields are 80 to 100 t/ha, and 65 t/ha for the ratoon crop. On marginal soils, for example Keppel and Tanby (see Section 5), under irrigation, plant and ratoon crop yields are 65 and 40 t/ha respectively.

Unlike pineapples, mangoes have a wide distribution throughout the survey area, with production areas expanding rather than decreasing. The central Queensland region is the most southern climatic zone in which mango yields are consistent. Average yields are 18 t/ha, but are considerably less on marginal soils. Several varieties are grown and the significant planting of late maturing varieties, R2E2 and Keitt, is a feature of the area. Some produce is exported.

The main growing area for papaws is the Yarwun - Targinie district near Gladstone (Photo 1). This area pioneered papaw growing in Queensland and used to produce the earliest fruit prior to development of the papaw industry in north Queensland. The combination of increased market competition, drought and disease have caused a decline in the local industry. There has been a major production shift to north Queensland where the climate is more favourable for this tropical plant.

Citrus has traditionally been grown in the Byfield district (Photo 2). Most citrus production is confined to mandarins (Imperial, Ellendale and Murcot). Approximately 50% of mandarins are exported, and produce of mandarins and lemons is supplied to domestic markets as far south as Melbourne. There is also a growing market for out of season (summer) lemon production. Current expansion occurs in the Emerald area and coastal production is likely to decline with change to higher value crops such as lychee and longan. Export potential, consistent yields and the feasibility of using netting structures to exclude pests provides an attractive alternative to citrus in this locality.

The major lychee variety grown is B3 (Kwai Mai Pink). It is a consistent producer from year to year and is the preferred market variety. Tai So is the other major variety grown because of its early seasonal production. However this variety is more irregular in its production and is declining in popularity. Chompoo and Haew are successful longan varieties grown at Byfield. The average yield of ten year old Tai varieties is 100 kg/tree in the region (Nicholls 1996).

Custard apple is another crop gaining popularity in the coastal district, where it represents the most northern area of significant planting. The early market window of February to April can be supplied by this district without significant competition from other regions. Early produced fruit is exported.

Apart from pineapples, mangoes papaws and citrus, a number of crops including avocado, banana, macadamia and lychee are minor but grown at some localities throughout the survey area. Most are tropical fruits with expansion restricted to coastal areas. Vegetable crops in conjunction with tree crops, are grown in the survey area, particularly cucurbits (rockmelon, zucchini, button squash and pumpkin) to maintain a cash flow and employment throughout the year.

Photo 1. Papaw plantation, Targinie

Photo 2. Citrus orchard, Byfield

3. Land suitability

3.1 Introduction

An assessment has been made of the survey area for its suitability for the production of vegetable crops, plantation, tree and vine crops, and sown pastures. Plantation crops include papaw and pineapple. The land suitability description (Sections 3.3-3.4) covers plantation, tree and vine crops only, this being the crop group most likely to expand in the area. Land suitability maps for plantation, tree and vine crops are provided separately for the Calliope and Yeppoon areas. Suitability maps for vegetable crops and sown pastures for smaller study areas are contained in interim reports (Ross 1996a-g, 1997a,b).

Land suitability assessment is based on the recognition of limitations to the production of existing and potential crops and pastures for the area. The limitations considered in this assessment are climate, frost, flooding, wetness, soil water availability, surface condition, soil workability, rockiness, water erosion, wind erosion, nutrient deficiency, slope and topographic complexity.

Irrigation is essential for the economic production of all crop types considered in this assessment, except pineapple which can be grown successfully under dryland conditions. This assessment assumes sufficient water for irrigation is available from either on-farm or reticulated sources and of adequate quality. Sown pastures are assessed under dryland conditions with a prepared seedbed.

A local land suitability framework for land assessment was compiled from survey information, landholder and extension staff experience. The suitability framework (Appendix I) has been applied to different combinations of crop and pasture groups, each with similar land use requirements, based on current land use throughout the survey area. Land has been allocated to one of five classes based on its potential to attain optimum production with minimal, long-term degradation (Land Resources Branch Staff 1990).

The land suitability classes are:

Class 1 **Suitable land with negligible limitations** which is highly productive requiring only simple management practices to maintain economic production

Class 2 **Suitable land with minor limitations** which either reduce production or require more than simple management practices of Class1 to maintain economic production

Class 3 **Suitable land with moderate limitations** which either further lower production or require more than those management practices of Class 2 land to maintain economic production

Class 4 **Marginal land with severe limitations** which make it doubtful whether the inputs required to achieve and maintain production outweigh the benefits in the long-term

Class 5 **Unsuitable land with extreme limitations** that preclude its use

The suitability class for a parcel of land is determined by rating limitations with increasing severity on a scale of 1 to 5. The limitation rating is known as a *subclass* and generally the level of the most severe limitation subclass is taken to determine the final land suitability class. For example the most severe limitation may have a slope rating of 4 which would result in a suitability rating of Class 4. The limitation subclasses for particular attribute levels are given in Appendix I. In some cases, a number of limitations in combination may downgrade the overall land suitability of an area.

Land has been grouped on the basis of limitations to show the range of crops land would support. The soil and land attributes in one of these groupings or categories are similar and suited to the same suite of

crops, require similar management, and have similar productivity and responses to management. No Class 1 land is recognised in the survey area because all land has some form of limitation to sustainable production. There are two categories of Class 2 land for plantation, tree and vine crops as land of this class has few limitations. For the remaining classes (3, 4 and 5), of this land use group, eight categories of land are recognised in the Calliope area and thirteen in the Yeppoon area.

3.2 Limitations to crop and sown pasture production

Climate (c). Average annual rainfall over the survey area increases in a northerly direction from 942 mm at Calliope to 1340 mm at Yeppoon, and to 1691 mm at Byfield (Source: Bureau of Meteorology). This attribute was used to establish three climatic zones (Appendix I). The ideal climate for most crops is dry, with rainfall substituted by irrigation. Crop production is affected by higher rainfall and associated humidity as it increases the difficulty in controlling fungal diseases and insect populations. Fruit splitting occurs with crops requiring a dry season finish. Winter and spring rainfall amounts are low affecting sown pasture production in all areas.

The Calliope area with the driest climatic zone is more favourable for crop production. A minor (c_2) climatic limitation applies to fig and grape production only. For the Yeppoon area, an extreme (c_5) limitation rating has been applied to grape production as summer rains cause splitting of maturing fruit and increased incidence of disease. A minor (c_2) limitation applies to mango, stonefruit, avocado and vegetable crops as fruit development is affected by wet conditions. Higher rainfall and humidity at Byfield is less favourable for crop production with several crop types having severe or extreme (c_4-c_5) limitations. Pineapple, papaw and lychee are more tolerant of these local conditions.

Frost (cf). The frost limitation is a specific climatic limitation and is used because of it`s potential to damage or kill tropical plants. Plants vary in susceptibility to frost at various stages of growth. For example, frost will kill young avocado trees but mature tree will tolerate a light frost. Restricted planting dates and the choice of crops also occur. Day temperatures during winter are generally quite mild in the survey area but night temperatures can be quite cold due to large radiation losses. Ground temperatures to minus ten degrees have been recorded at Yarwun. Winter frosts are less damaging than those of early or late occurrence. Examples of low lying frost free land are Farnborough and the Boyne River terraces adjacent to Awoonga Dam. The chilling requirement of stonefruit and grape is assumed to be adequate at these localities.

Fig, persimmon, citrus, grape and stonefruit are frost tolerant. A negligible (cf_1) frost limitation has been assigned to land for this crop group. Lychee, macadamia, mango and carambola are less tolerant of frost, particularly during early stages of growth. Land with an incidence of heavy winter frost results in a severe (cf_4) limitation rating. Custard apple, avocado, papaw, pineapple and passionfruit are least tolerant, and where heavy frost occurs, an extreme (cf_5) limitation applies. For vegetable crops, frost free land is ideal as it allows early marketing and the ability to fill seasonal supply gaps. The limitation is less severe in application for sown pastures. Land with an extended frost occurrence was given a moderate (cf_3) rating.

Water availability (m). Crop yields and pasture dry matter production depend on an adequate supply of soil water to achieve optimum growth and production. On irrigated land a reduced soil water storage capacity results in less than optimum yields unless more frequent irrigation is applied. Most established tree crops require an even supply of soil water to maintain satisfactory growth. Critical times to supply adequate moisture are prior to flowering, fruit set and fruit filling. The lower the soil water storage the more difficult it is to maintain an adequate moisture supply, particularly during prolonged dry periods.

Sown pastures and pineapples are assessed under dryland conditions, and other crops using a trickle irrigation system. Attribute levels for various crop groups were determined from estimated plant

available water capacity (PAWC). Vine crops (grape and passionfruit) have a lower annual water requirement and soils with >125 mm PAWC were given a negligible (m_1) water availability limitation. For tree crops, soils with an estimated PAWC of <60 mm over 1.2 m depth would require almost continuous irrigation during critical growth stages and were assigned an extreme (m_5) water availability limitation. A severe (m_4) limitation applies to soils with 60-75 mm PAWC. These generally correspond to the deep sands. The deep red soils of higher clay content (Elizabeth and Lizard) with an estimated PAWC of 125-150 mm were assigned a minor (m_2) water availability limitation. Subclasses for vegetable crops were determined over a shallower rooting depth (0.5 m) and are shown in Appendix I.

Nutrient deficiency (nd). Most soils in the survey area have low fertility and low nutrient retention characteristics. This applies particularly to the deep red soils (Elizabeth and Lizard) which are widely used for horticultural production. Phosphorus was the main plant nutrient identified by growers as requiring the most frequent application. Calcium deficiency has been recorded in cucurbits crops. For crop production, the nutrient deficiency limitation has not been used to downgrade the suitability of land because fertilisers can be easily applied and their use is a standard management practice. Molybdenumised superphosphate and di-ammonium phosphate are used in the Yeppoon area to increase sown pasture productivity.

For dryland sown pastures nitrogen and phosphorus deficiencies reduce the quantity and quality of dry matter. Soils were given a nutrient deficiency limitation rating (nd_1-nd_4) based on soil surface fertility, local landholder experience and selected sampling. Subclasses represent increasing deficiencies in combinations of phosphorus, nitrogen and other nutrients. A severe nutrient deficiency limitation (nd_4) has been applied to soils with the widest range of nutrient deficiencies. These are generally deep sands and very thick sandy surfaced texture contrast soils which are easily leached. There is no economic response for pasture production to fertiliser application on these soils under dryland conditions at Byfield.

Wetness (w). The wetness limitation is the most important limitation in assessing the suitability of land for horticultural use. Saturated soil conditions provide an unfavourable environment for plant roots and beneficial soil micro-organisms. Reduced aeration favours the presence of anaerobic bacteria and a reduction in nutrient uptake by plants. Waterlogged soils warm slowly because more heat is required to raise the temperature of saturated soil. Poor drainage reduces the root zone area from which nutrient uptake occurs. Soils with slight drainage problems are often overlooked because they will produce a crop under most conditions but the extent to which yields are reduced should be evaluated with adjacent well drained soils. Landholder experience indicates reduced yields of >40% and lower fruit quality of mangoes on soils with impeded drainage conditions. Mounding of surface soils is practiced at some locations to improve surface drainage. Subsurface drainage occurs on some pineapple plantations.

Heavy clay soils with high water retention were allocated an extreme (w_5) wetness limitation for crop production, irrespective of site characteristics. Sodic and magnesic texture contrast soils were given an extreme (w_5) wetness limitation for pineapple and vegetable crop production where surface thickness was less than 0.3 m. Avocado and grape are least tolerant of impeded drainage conditions and an extreme (w_5) wetness limitation was applied to land not well or rapidly drained to 1.5 m depth. Custard apple and papaw require well drained land to a shallower depth (0.5-1 m) and, where impeded drainage conditions occur within this depth, a severe (w_4) wetness limitation applies. A severe (w_4) wetness limitation was applied for the remaining plantation, tree and vine crops on imperfectly drained land.

Vegetable crops have a shallow root system and were assessed over a depth of 0.3-0.5 m. Imperfectly drained land at this shallow depth was assigned an extreme (w_5) limitation. The wetness limitation is less severe for sown pastures and a negligible (w_1) rating applies to moderately well drained to rapidly drained land. A moderate rating (w_3) was given to imperfectly drained land for all pasture species except setaria. Setaria is able to tolerate poorly drained conditions and a moderate limitation rating (w_3) was applied for this pasture type.

Flooding (f). The flooding limitation is used to downgrade the suitability of land susceptible to erosive flooding resulting from stream channel overflow. Erosive flooding affects crop and sown pasture production by scouring seedbeds, flattening plants and depositing sediment. Crop and pasture damage caused by waterlogging following flooding is not covered by this limitation, but assessed in the wetness limitation (site component of drainage class).

Erosive flooding in the survey area is restricted to creek flats and terraces. A severe (f_4) flooding limitation has been assigned to these areas with a flood frequency of more than one flood event in five years based on landholder experience. Where flood frequency is less (1:5 to 1:10 years), for example along Water Park and Limestone Creeks, a moderate (f_3) limitation applies. A minor (f_2) flooding limitation was given to flood prone land with a flood frequency of less than one occurrence in ten years.

Surface condition (ps). Soils have a characteristic surface condition when dry which is largely attributed to soil texture, structure and consistence. Types range from loose or self-mulching to hardsetting or crusting. Surface condition affects vegetable crop and sown pasture production by reducing water entry, restricting soil aeration and impeding seedling emergence particularly for small seeds. The limitation does not apply to plantation, tree and vine crops as these are planted as seedlings.

A loose soil surface, for example a fine sand, presents an extreme (ps_5) limitation for mechanical harvesting (vacuum and finger rake) of macadamia nuts. For sown pastures and vegetable crops, the same subclass ratings apply. A negligible (ps_1) surface condition limitation was assigned to soils with a fine surface structure or surface texture of sand, as seedling emergence and plant establishment rates are high on soils with these attributes. Rollers are used on soils with a coarse surface structure to improve soil seed contact for pasture establishment. These soils are predominantly clays and were given a minor (ps_2) surface condition limitation. Local landholder experience indicates poor pasture response to rainfall on very hardsetting or crusting surface soils, and a severe (ps_4) limitation was applied.

Soil workability (k). The limitation is applied where tillage is carried out for seedbed preparation, planting, weed control and renovation. Land is considered more suitable for crop production if tillage can be undertaken over a wide range of moisture conditions without damaging the soil profile. Tilling a soil that is too wet (except sand) causes compaction and soil adhesion. This impairs plant growth, restricts water infiltration and encourages erosion. If the soil being tilled is too dry, excessive draft energy is required. Some silty soils, low in organic matter, will pulverise when tilled too dry, and form a surface crust with subsequent wetting and drying. Abrasiveness, a component of soil workability, affects implement wear particularly where chert and ironstone gravels are present.

Sands, structured loams and self-mulching clays are easy to work over a wide range of moisture conditions and were assigned a negligible (k_1) limitation. A minor (k_2)limitation rating applies to hardsetting fine sandy loam to silty clay loam surface soils. Very hardsetting surface soils or medium heavy clays were assigned a moderate (k_3) limitation rating. Gravelly abrasive soils present a moderate limitation for pineapple and papaw production, but a severe (k_4) limitation for vegetable crop production as tillage is undertaken more frequently.

Water erosion (e). Water runs off the soil surface when the rate of rainfall exceeds the rate of infiltration of water into the soil. Any factor that reduces the permeability of soil increases the likelihood of runoff. Severe erosion is usually caused by unsuitable farming practices. Water erosion leads to reduced productivity unless control structures and agronomic practices are employed. High intensity short duration rainfall events are a feature of tropical coastal areas. Agricultural practices that involve large bare areas during such events have high erosion risk (Photo 3).

Photo 3. Pineapple plant crop with water erosion, gently sloping land, Yeppoon

The amount of soil loss for an area is determined by rainfall characteristics, soil properties, land slope and management practices. Rainfall intensities of 50 mm to 170 mm per hour were recorded at a pineapple trial site near Yeppoon in January 1996 (D Chapman *pers. comm.*). During these rainfall events soil loss from interrow furrows with bare soil was ten times greater than soil loss from rows with tied ridges and pineapple mulch. Similar results were recorded at the Yarwun papaw trial site during the same period. Soil loss on bare areas between contoured drains showed a twelve fold increase over mulched areas (R Gillespie *pers. comm.*).

The modal slope angle has been used in applying the water erosion limitation for each mapped area. The upper slope limit for frequently cultivated land suitable for vegetable cropping has been set at 8%. A severe (e_4) water erosion limitation has been applied to land for vegetable cropping where the modal slope angle is between 8 and 12%. Local experience indicates the water erosion hazard to be high (e_4) for pineapple production on slopes of between 8 and 15%, but unacceptable (an extreme limitation) on slopes >15%.

The upper slope limit suitable for perennial tree crops has been set at 15% as steeper slopes are used in conjunction with a permanent grass sward. Erosion potential is high during land preparation, establishment and at maturity with canopy closure. The long-term erosion protection provided by sown pastures is greater than that provided by vegetable crops and pineapples. However a severe (e_4) water erosion limitation has been applied to land with slopes of between 15 and 20%, because seedbed preparation and renovation will be undertaken during periods of high erosion risk.

Wind erosion (a). Most soils in the survey area have a coherent soil surface when dry and a surface texture heavier than sand. Areas most susceptible to wind erosion occur immediately adjacent to the coast. This type of erosion was observed during the survey on texture contrast soils with a fine sandy surface up to 17 km from the coastline.

Erosion by wind removes soil particles, organic matter and plant nutrients resulting in reduced productivity. Scalding and windsheeting leave the surface bare and extremely difficult to regenerate.

Tillage for crop and pasture production provide opportunities for soil loss. Frequent tillage increases the susceptibility of the soil surface to wind erosion. Extended periods of low rainfall, high temperatures and high wind velocity contribute to the severity of wind erosion on a bare soil surface.

The limitation is applied at locations where management inputs required to reduce the erosion risk during establishment are considered uneconomic. For example, the broad scale clearing of beach ridges would require placement of closely spaced structures until an adequate surface cover was established. Coherent surface soils have no apparent wind erosion hazard and were given a negligible (a_1) limitation rating. Surface soils of loose fine to medium grain sand were considered to have a severe (a_4) limitation for most plantation, tree and vine crops, and sown pastures. Pineapple and vegetable crops were assigned an extreme (a_5) limitation rating as the frequency of tillage and soil surface exposure is considerably higher for these uses.

Rockiness (r). Gravel is a feature of many soils in the survey area, while cobble and stone is associated with few soils. Rock outcrop is less common and usually occurs on dissected low rises and steep hill crests. Large amounts of gravel, cobble, stone and rock outcrop in the plough zone impedes cultivation and damages machinery. The effects of rockiness on abrasion and soil water storage are components of the soil workability and water availability limitations.

The limitation has been assessed on the presence of coarse fragments (gravel, cobble and stone) within the plough zone (0-0.2 m) depth. Where combinations of coarse fragment sizes occur, the most severe attribute level was applied. With the exception of pineapples, most plantation, tree and vine crops are long-term perennials and do not require cultivation. Damage to machinery is likely to occur when slashing or mowing for weed control, and an extreme (r_5) rockiness limitation was given to land with >50% cobble or >20% stone. For pineapple production, mulching of ratoon crops and bed preparation requires infrequent tillage. An extreme (r_5) rockiness limitation applies where cobble and stone are >50% or >10% respectively.

Surface coarse fragments severely restrict the mechanical harvesting of macadamia nuts and an extreme (r_5) limitation rating was assigned to land with >20% gravel or >2% cobble and stone. Land with <10% gravel or <2% cobble was given a minor to moderate (r_2-r_3) rating for vegetable crop production as this land use requires frequent tillage.

Slope (ts). There are no large areas of flat land being used or having potential for horticultural use in the survey area. The slope limitation has been used to downgrade the suitability of sloping land as increasing slope angle restricts the safe use of machinery. The upper slope limits for limitation subclasses correspond with those of the water erosion limitation.

Farm machinery accidents are largely related to operator error, the mechanical condition of machinery and environmental conditions. While environmental conditions cannot be controlled the effects of these can. Steep slopes for example, can be avoided, to permit the safe use of machinery.

Slopes <12% where machinery operations are undertaken frequently are regarded as safe for machinery use, with only a minor (ts_2) limitation. An extreme (ts_5) limitation rating has been applied for vegetable crop production where the modal slope angle of areas exceeds 12%.

Machinery operations are less frequent for the production of plantation, tree and vine crops and a moderate (ts_3) limitation rating has been applied to land with slopes of 12-15%. Occasional use for pasture establishment and renovation may occur within this slope range with a minor (ts_2) limitation rating. A severe (ts_4) limitation rating has been applied for both land uses on land with slopes of 15 to 20%. Slopes of this range prevent the safe use of most implements and this becomes a limitation to cultivation. Slopes >20% are regarded as unsafe for machinery use even when infrequent.

Topographic complexity (xt). Complex topography affects the use of machinery for cultivation, weed and pest control and for harvesting operations. Machinery use is more efficient on relatively large areas of land with an even surface. Dissected land due to natural or eroded gullies prevents the efficient use of land for agricultural production. Cropping areas must conform to gully patterns and the gullies themselves are a barrier to the passage of machinery. Severely dissected land precludes its use.

Limitation subclasses were established for 1:50 000 scale mapping based on land surface features. Undissected flat or sloping land is most suitable for production with a negligible (xt_1) limitation. For crop production, areas with a minor (xt_2) limitation are very weakly dissected with uniform slopes and an occasional gully. Creek flats and low river terraces are usually more strongly dissected with an undulating surface and most have a moderate (xt_3) limitation rating. A severe (xt_4) limitation rating was applied where gully dissection and / or complex slopes significantly fragment land and increase difficulty in machinery use. An extreme (xt_5) limitation applies to strongly dissected land with steep (>20%) complex slopes and narrow crests. The limitation is less severe in application for sown pasture production because machinery operations for sowing and renovation are less frequent.

3.3 Suitability for plantation, tree and vine crops - Calliope Area

Land was assessed in the Calliope area for its suitability to grow fig, persimmon, citrus (mandarin and lemon), grape, low chill stonefruit (peach and nectarine), custard apple, avocado, papaw, lychee, macadamia, mango, carambola and passionfruit using a trickle irrigation system. Crop suitability was found to be limited and to vary considerably in the survey area. A few areas (119.6 ha) are very versatile and well suited to grow all of these crops (Class 2 land). Other areas (2278 ha) because of their limitations have a wide to restricted range of crop suitability (Class 3 land). Some areas (1693 ha) are marginal for several crops (Class 4 land). Only 2397.5 ha, or 8.8% of the area has been assessed as suitable land for plantation, tree and vine crops.

The survey area has been categorised and mapped according to its cropping versatility. Nine categories of land are described below in terms of their suitability for cropping, limitations, soils and current land use. Brief descriptions of the soils are provided in the Calliope soil map reference and Section 5 of this report. The nine categories are:

Land CategoriesArea	**Area (ha)**
Class 2 land with minor limitations suitable for fig, persimmon, citrus, grape, stonefruit custard apple, avocado, papaw, lychee, macadamia, mango, carambola and passionfruit	119.6
Class 3 land with moderate limitations suitable for fig, persimmon, citrus, grape, stonefruit custard apple, avocado, papaw, lychee, macadamia, mango, carambola and passionfruit	789.4
Class 3 land with moderate limitations suitable for fig, persimmon, citrus, stonefruit, custard apple, papaw, lychee, macadamia, mango, carambola and passionfruit	98.9
Class 3 land with moderate limitations suitable for fig, persimmon, citrus, stonefruit, custard apple, papaw, lychee, mango, carambola and passionfruit	716.4
Class 3 land with moderate limitations suitable for fig, persimmon, citrus, stonefruit, lychee, mango, carambola and passionfruit	673.2
Class 4 land with severe limitations marginal for fig, persimmon, citrus, grape, stonefruit, custard apple, avocado, papaw, lychee, mango, carambola and passionfruit	118.4
Class 4 land with severe limitations marginal for fig, persimmon, citrus, stonefruit, lychee, macadamia, mango, carambola and passionfruit	1549.8
Class 4 land with severe limitations marginal for fig, persimmon, citrus and stonefruit	24.5
Class 5 land unsuitable for plantation, tree and vine crops	22926.3

Class 2 land with minor limitations suitable for fig, persimmon, citrus, grape, stonefruit, custard apple, avocado, papaw, lychee, macadamia, mango, carambola and passionfruit

This land is suited to cropping for the widest range of crop types. It is characterised by deep well drained soils on gentle slopes. The soils are **Elizabeth, Lizard** and **Carmine**. These soils have a moderate to high plant available water capacity, and are largely gravel free.

Small areas of this land class occur in the Beecher and Targinie localities. The land is used for grazing, sown pastures and cropping. Sown pastures include Rhodes grass, green panic and stylo. Green panic is sown for fallow weed control in papaws. Plantation and tree crops include papaw, mango and lychee.

Limitations to crop production are minor and include water availability (m_2), water erosion (e_2) and frost (cf_2). Although irrigation frequency is less than on soils of lower clay content, these soils require substantial amounts of water to maintain production, due to their freely draining characteristics. All of the soils occur on landforms which are sloping and where slope angle exceeds 5% a minor water erosion limitation applies. Low lying areas experience light winter frost.

Class 3 land with moderate limitations suitable for fig, persimmon, citrus, grape, stonefruit, custard apple, avocado, papaw, lychee, macadamia, mango, carambola and passionfruit

The same wide range of crop types are suitable on this land but with moderate limitations. The soils are deep and well drained. Most are associated with terraced alluvium of the Boyne River. These are **Berrigan, Benaraby, Boyanda, Ceduna** and **Catalina**. **Meilland** and **Carmine** soils represent areas of granitic footslopes in the Targinie valley and at Mount Sugarloaf.

Commercial production of mango and papaw occur mainly within this land unit, however a significant proportion is used for grazing and sown pastures. Some avocado, citrus, macadamia, persimmon, grape and cucurbit crops are also grown. Sown pastures include setaria, siratro, green panic and Rhodes grass. Small areas are used for irrigated annual forage sorghum.

Limitations to crop production include water availability (m_3), topographic complexity (xt_{2-3}) and frost (cf_2). The soils have a moderate plant available water capacity and will require frequent irrigation to maintain optimum growth and production. **Catalina** soil has complex topography and a frost limitation for frost sensitive crops.

Class 3 land with moderate limitations suitable for fig, persimmon, citrus, stonefruit, custard apple, papaw, lychee, macadamia, mango, carambola and passionfruit

Avocado and grape have been excluded from this crop group because these crops are less tolerant of impeded drainage conditions. All other crops have been given a moderate (w_3) wetness limitation. The flat to gently sloping river terraces with **Catalina**, **Ceduna** and **Harwood** soils have restricted surface drainage. The soils have restricted internal drainage indicated by manganese segregations and mottling in the lower clay subsoil.

This land class is restricted to the lower section of Boyne River alluvium from Benaraby to South Trees Inlet. Land use is predominantly grazing beef cattle on native and sown pastures. Sown pastures include Rhodes grass, setaria and stylos. Horticultural tree crops are a minor land use. Some mango, macadamia and pecan are grown.

Class 3 land with moderate limitations suitable for fig, persimmon, citrus, stonefruit, custard apple, papaw, lychee, mango, carambola and passionfruit

This land is characterised by soils with a gravelly to cobbly surface, or by soils with a loose non-coherent surface condition when dry. These characteristics severely affect the mechanical harvesting of macadamia nuts either by a vacuum or finger rake method. Major soils are **Muldoon**, **Beecher** and **Doonside**. Minor soils include **Meilland**, **Swans** and **Boyanda**. Avocado and grape have also been excluded from this crop group because of drainage restrictions in the soil profile above 1.5 m depth.

The land is used for grazing, cropping and rural-residential use. Most cropping occurs in the Yarwun-Targinie area, and mango is the dominant tree crop. Some papaw, stonefruit, citrus, lychee, custard apple and passionfruit are also grown.

Limitations for this crop group are moderate and include water availability (m_3), wetness (w_3), water erosion (e_3) and frost (cf_2). Gravelly red gradational and texture contrast soils (**Muldoon**, **Beecher** and **Doonside**) were estimated to have a moderate plant available water capacity due to moderate depth and high gravel content. A moderate PAWC applies also to soils of light texture (**Meilland**, **Swans** and **Boyanda**). No soils in this land class have free drainage to 1.5 m depth, due to topographic position, moderate soil depth or occurrence of buried soil layers of high clay content. Slopes are >8% in some places with potential for water erosion. Low lying areas experience light winter frost.

Class 3 land with moderate limitations suitable for fig, persimmon, citrus, stonefruit, lychee, mango, carambola and passionfruit

Avocado, grape, custard apple and papaw have been excluded from this crop group because of the likely drainage restrictions in the soil profile during prolonged wet periods, or frost intolerance of frost sensitive crops. Macadamia has also been excluded because the high content of surface gravel and cobble severely restricts mechanical harvesting. Major soils are **Doonside**, **Boyles** and **Muldoon**. Minor soils include **Valetta**, **Cobbleton** and **Carmine**. A small area of **Diglum** with impeded drainage and a non-gravelly surface has been related to this land class.

The land is used mainly for grazing beef cattle on native pasture. A few areas have been cultivated for improved pasture, particularly Rhodes grass. Mango is the dominant tree crop. Some persimmon, citrus, custard apple, stonefruit and banana are also grown.

Limitations for this restricted crop group are moderate and include water availability (m_3), wetness(w_3), frost (cf_3) and topographic complexity (xt_3). All of the soils have a moderate soil water availability limitation , and / or a moderate wetness limitation. Some areas have a moderate water erosion limitation, while others where gullied have a moderate topographic complexity limitation. Low lying areas have an extended frost period.

Class 4 land with severe limitations marginal for fig, persimmon, citrus, grape, stonefruit, custard apple, avocado, papaw, lychee, mango, carambola and passionfruit

Soils with a sand texture profile (sand, loamy sand) characterise this unit. The soils are **Arnica**, **Kinka** and **Valetta**. These soils have a low plant available water capacity (60-75 mm), are well or rapidly drained, and have a loose surface condition when dry. A wide range of crops are marginal on this land, except macadamia. A loose sandy soil surface presents an extreme limitation for mechanical harvesting of macadamia nuts.

There is no commercial production of horticultural crops on this land. It is used mainly for grazing. Improved pasture of Rhodes grass and stylos occurs on an area of this land unit adjacent to the Calliope River. A small area is used for sand extraction near Tannum Sands.

Limitations to potential crop production are severe and include water availability (m_4), wind erosion (a_4) and flooding (f_{2-3}). Beach ridges near Tannum Sands with **Kinka** soil have a high wind erosion hazard if cleared for horticultural use. Creek terraces with **Valetta** soil and low river terraces with **Arnica** soil are susceptible to erosive flooding.

Class 4 land with severe limitations marginal for fig, persimmon, citrus, stonefruit, lychee, macadamia, mango, carambola and passionfruit

Unlike the previous category, the soils of this land class are generally shallow and not as well drained. Some have gravelly surface horizons. Major soils are **Muldoon**, **Bompa**, and **Voewood**. Minor soils include **Doonside**, **Yaxley** and **Harwood**. Avocado, grape, custard apple and papaw are not included in this crop group because the minimum depth for soil drainage is inadequate for these crops. The land is marginal for the remaining crops because plant available water capacity is low, due to soil depth or sodicity of the clay subsoil. Some areas have complex soil distribution or complex topography.

Grazing is the dominant land use throughout this unit. Some areas have been sown with improved pastures of Rhodes grass and stylos. Mango is the main tree crop grown, and a small area is used for papaws. Most cropping occurs on a mounded soil surface to improve surface drainage.

Limitations to crop production are severe. These are water availability (m_4) and wetness (w_4). The soils have a low soil water storage capacity and will require frequent irrigation to maintain optimum growth and production. The texture contrast soils **Voewood**, **Yaxley** and **Harwood** are imperfectly drained with a severe wetness limitation. Areas with **Doonside** soil are gullied and have complex topography.

Class 4 land with severe limitations marginal for fig, persimmon, citrus and stonefruit

Corduroy is the only soil within this class. It is a dark structured gradational soil with good internal drainage. The low terrace of Clyde Creek where this soil is dominant, experiences frequent heavy frosts during winter months, and can experience frequent flooding during summer months. Only the very frost tolerant crops comprise this crop group.

Although this crop group can tolerate a severe frost (cf_4) limitation, the land is susceptible to a severe flooding (f_4) limitation and therefore marginal for this potential use. A minor wetness (w_2) limitation applies following flooding, as the soil has unrestricted internal drainage. The land is currently used for grazing.

Class 5 land unsuitable for plantation, tree and vine crops

Much of this unit is made up of shallow gravelly soils on steep hills and steep rises, texture contrast and stony soils on gently undulating to undulating rises, texture contrast soils and heavy clays on plains, river terraces, and in drainage lines. Some areas are affected by tidal influence. Almost half (29) of the soils are specific to this unit. Other soils which occur in this unit have extreme limitations, or combined limitations which in aggregate are extreme.

Most land in this unit is used for grazing beef cattle on native pasture of varying productivity. Some areas have been broadcast (over sown) with stylos, and a few are cultivated for annual forage sorghum. A proportion is used for rural-residential and urban uses. Some mangoes and papaws are grown on steep hillslopes. Gravel and sand extraction occur at a few locations throughout the unit.

Darts, **Coorooman**, **Gayfield**, **Muldoon**, **Beaks** and **Doonside** soils on steep slopes (>20%) have an extreme (e_5) water erosion and slope limitation (ts_5) for the safe use of machinery. Sodic / magnesic texture contrast soils on rises (**Keppel**, **Awoonga**, **Newby**, **Conway** and **Yarwun)** have impeded drainage with a severe (w_4) wetness limitation, and very low plant available water capacity with an

extreme (m_5) water availability limitation. Soils of coarse sand texture (**Iveragh**), and with stony profiles (**Stoneleigh**, **Cammoo** and **Shingle**), also occur on rises with extreme (m_5) water availability and rockiness (r_5) limitations respectively. Sodic / magnesic texture contrast soils on river terraces (**Camona**, **Dorall**, **Kenway** and **Pitt**) and of plains and drainage lines (**Yaringa**, **Adsett**, **Kindara** and **Lorna**) have impeded drainage with a severe or extreme (w_4-w_5) wetness limitation, and an extreme (m_5) water availability limitation. Heavy clay soils with high water retention, on river terraces (**Larcom**, **Stowe**, **Marla**, **Narva** and **Evander**) and of plains and drainage lines (**Cassandra** and **Ashen**), have an extreme (w_5) wetness limitation. Saline clays of tidal flats (**Tilden** soil) are precluded. Excavated and eroded land form part of this land unit.

3.4 Suitability for plantation, tree and vine crops - Yeppoon Area

Land was assessed in the Yeppoon area for its suitability to grow fig, persimmon, citrus (mandarin and lemon), low chill stonefruit (peach and nectarine), custard apple, avocado, papaw, lychee, macadamia, mango, carambola, and passionfruit using a trickle irrigation system. Pineapple was assessed under dryland conditions. Crop suitability was found to vary considerably in the survey area. Some areas (1665.3 ha) are very versatile and well suited for growing many of these crops (Class 2 land). Other areas (2752.4 ha) because of their limitations have a restricted range of crop suitability. Some areas (6300.3 ha) are marginal for certain crops but totally unsuitable for others (Class 4 land). Approximately 4400 ha, or 18.2% of the area, was assessed as suitable land for plantation, tree and vine crops.

The survey area has been categorised and mapped according to its cropping versatility. Fifteen categories of land are described below in terms of their suitability for cropping, limitations, soils and current land use. Brief descriptions of the soils are given in the Yeppoon soil map reference and Section 5 of this report. The fifteen categories are:

Land Categories	Area (ha)
Class 2 land with minor limitations suitable for fig, persimmon, citrus, stonefruit, custard apple, avocado, papaw, pineapple, lychee, macadamia, mango, carambola and passionfruit	1371.7
Class 2 land with minor limitations suitable for fig, persimmon, citrus, stonefruit, custard apple, papaw, pineapple, lychee, macadamia, mango, carambola and passionfruit	293.6
Class 3 land with moderate limitations suitable for fig, persimmon, citrus, stonefruit, custard apple, papaw, pineapple, lychee, macadamia, mango, carambola and passionfruit	689.4
Class 3 land with moderate limitaions suitable for fig, persimmon, citrus, stonefruit, lychee, mango, carambola and passionfruit	995.5
Class 3 land with moderate limitations suitable for fig, persimmon, citrus, stonefruit, lychee, mango, carambola and passionfruit	167.9
Class 3 land with moderate limitations suitable for persimmon, citrus, custard apple, papaw, pineapple, lychee, macadamia, carambola and passionfruit (Byfield only)	612.5
Class 3 land with moderate limitations suitable for persimmon, citrus, custard apple, papaw, lychee, macadamia, carambola and passionfruit (Byfield only)	234.3
Class 3 land with moderate limitations suitable for pineapple (Tanby only)	52.8
Class 4 land with severe limitations marginal for fig, persimmon, citrus, stonefruit, custard apple, avocado, papaw, lychee, mango, carambola and passionfruit	212.1
Class 4 land with severe limitations marginal for fig, persimmon, citrus, stonefruit, custard apple, papaw, lychee, mango, carambola and passionfruit	116.3
Class 4 land with severe limitations marginal for fig, persimmon, citrus, stonefruit, lychee, mango, carambola and passionfruit	432.2
Class 4 land with severe limitations marginal for persimmon, citrus, custard apple, papaw, lychee, carambola and passionfruit (Byfield only)	99.2
Class 4 land with severe limitations marginal for persimmon, citrus, lychee, macadamia, carambola and passionfruit (Byfield only)	538.9
Class 4 land with severe limitations marginal for pineapple	4901.6
Class 5 land unsuitable for plantation, tree and vine crops	13547.5

Class 2 land with minor limitations suitable for fig, persimmon, citrus, stonefruit, custard apple, avocado, papaw, pineapple, lychee, macadamia, mango, carambola and passionfruit

Landform and soil characteristics are essentially the same for Class 2 land in the Calliope area. However, wetter climatic conditions are less favourable for some crops (fig, mango, stonefruit and avocado), and exclude grape production. Despite a climatic limitation for some crops, this land is very versatile and well suited to cropping for a wide range of crop types. The soils are **Elizabeth**, **Lizard** and **Beecher**. These soils are estimated to have a high plant available water capacity, are well drained to 1.5 m depth, and are largely gravel free.

A large proportion of this land has been previously used for pineapple production. Current land use is predominantly grazing beef cattle on volunteer, native and sown pastures. Sown pastures include Rhodes grass, green panic, setaria, stylo and forage sorghum. Some areas are mown for hay for use as stockfeed or tree mulch. Commercial production of pineapple, mango and macadamia occur throughout this land unit. Some avocado, custard apple, banana, citrus, lychee, longan, black sapote and vegetable crops (watermelon, pumpkin and zucchini) are also grown.

Limitations to crop production are minor and include climate (c_2), water availability (m_2) and water erosion (e_2). Most of the land is gently sloping (<5% slope), and in some areas where slopes are between 5 and 8% a minor water erosion limitation applies. The water erosion hazard is higher for pineapple production. A gravelly soil surface horizon associated with **Beecher** soil and some areas with **Lizard**, presents a minor rockiness limitation for mechanical harvesting of macadamia nuts.

Class 2 land with minor limitations suitable for fig, persimmon, citrus, stonefruit, custard apple, papaw, pineapple, lychee, macadamia, mango, carambola and passionfruit

Avocado is excluded from this crop group because the soils of this land class are <1.5 m deep or exhibit drainage restrictions (reticulate mottle) in the soil profile above 1.5 m depth. Major soils are **Lizard** and **Elizabeth**. The land unit includes a small area with **Beecher** soil.

Soil drainage is adequate for this crop group. Limitations are minor and include water availability (m_2) and water erosion (e_2). Most of the land is used for grazing. Some forage cropping and pasture improvement (Rhodes grass) occurs. Plantation and tree crops recorded include pineapple, mango, lychee, carambola and custard apple.

Class 3 land with moderate limitations suitable for fig, persimmon, citrus, stonefruit, custard apple, papaw, pineapple, lychee, macadamia, mango, carambola and passionfruit

This land has moderate limitations for this crop group. The soils have impeded drainage conditions, or a lower soil water storage capacity. Slopes are often steeper than in the previous land categories. Avocado is excluded because the crop is less tolerant of impeded drainage conditions. Red to yellowish brown gradational textured soils (**Beecher** and **Farnborough**) are dominant. Most other soils of this unit are red to yellowish brown and texture contrast (**Doonside, Barrack, Stevens** and **Ebon**).

Land utilisation includes grazing, pasture improvement and cropping. Sown pastures are mainly Rhodes grass, pangola grass and stylos. Silk sorghum is sown at some locations for forage. Mango and pineapple are the more common crop types. Some macadamia, custard apple, lychee and papaw are also grown. A small area is used for vegetable cropping (zucchini, tomato and watermelon).

The most critical limitation levels for crop production are wetness (w_3), water erosion (e_3) and water availability (m_3). Manganese nodules in the clay subsoil of **Farnborough** and **Ebon** soils indicates restricted internal drainage, while surface drainage on slopes is unrestricted. Very gently sloping creek terraces with **Ruby** soil have restricted surface drainage, but the soil has good internal drainage. The less

gently sloping areas (>8% slope), with **Elizabeth**, **Beecher, Stevens** and **Doonside** soils, have a moderate slope limitation and shallower soil depth. The water erosion hazard will be higher for pineapple production on these slopes.

Class 3 land with moderate limitations suitable for fig, persimmon, citrus, stonefruit, pineapple, lychee, mango, carambola and passionfruit

Avocado, papaw and custard apple have been excluded because of drainage restrictions in the soil profile during prolonged wet periods. Macadamia has also been excluded because surface gravel associated with most soils severely restricts mechanical harvesting. The soils have a moderate soil water storage capacity. Some areas have a moderate water erosion limitation. Major soils are **Doonside**, **Lizard** and **Ruby**. Minor soils include **Rosslyn**, **Sable** and **Ebon**.

Most of the land is used for grazing beef cattle on native and volunteer pastures. A few areas have been sown with improved pastures of Rhodes grass, setaria and stylos. Some mango, pineapple, lychee, macadamia and citrus crops are grown. A small area is used for vegetable crops (sweet corn, tomato and pumpkin).

Soils of this land class were assigned a moderate (m_3) soil water availability limitation. Those with surface gravel and cobble (**Doonside**, **Ruby**, **Lizard, Rosslyn**, **Ebon** and **Sable**), have a severe or extreme rockiness limitation for macadamia. Some areas have a moderate (e_3) water erosion limitation on slopes of 8 to 15%. Land within this slope range will have a higher water erosion hazard for pineapple production.

Class 3 land with moderate limitations suitable for fig, persimmon, citrus, stonefruit, lychee, mango, carambola and passionfruit

Excluded from this crop group are avocado, papaw, custard apple and macadamia because of restricted internal drainage and surface gravel. Pineapple has also been excluded due to frost or rockiness. The soils are gravelly red to brown, gradational or texture contrast (**Doonside**, **Cobbleton**, and **Ruby**) on hillslopes or creek flats, and non-gravelly dark gradational soils on creek terraces (**Corduroy**).

Nearly all the land of this unit is used for grazing. A few small areas of local alluvium have been cultivated for improved pasture, particularly setaria. A small area is used for macadamia, and another has recently been prepared for grapes.

Low lying areas with **Corduroy** and **Ruby** soils experience light winter frost. **Cobbleton** and **Doonside** soils have a moderate (m_3) soil water availability limitation, and a severe to extreme (r_4-r_5) rockiness limitation for pineapple and macadamia. Tillage for pineapple production is required for planting and replanting operations and the high amount of gravel and cobble severely restricts the use of infrequent tillage on this land.

Class 3 land with moderate limitations suitable for persimmon, citrus, custard apple, papaw, pineapple, lychee, macadamia, carambola and passionfruit (Byfield only)

For the Byfield area, mango, stonefruit, avocado, fig and grape have been excluded from the tree and vine crop group because of the difficulty in controlling fungal diseases and insect populations caused by higher rainfall and humidity. The climatic effect was considered to be less severe for the remaining crops.

The soils of this land class are **Flanders**, **Liston**, **Meilland** and **Valetta**. They occur on gently sloping granitic rises and terraced alluvium. **Meilland** and **Valetta** have deep (>1.5 m) uniform or gradational

texture profiles with good internal drainage. **Flanders** and **Liston** soils with a very thick loamy surface and texture contrast profile are well drained to shallower depth (1 m). All are gravel free and have a moderate soil water storage capacity.

Current land use is predominantly grazing, however a significant proportion of the unit is utilised for rural-residential use. Some areas are sown with annual forage sorghum for fodder. Citrus (mandarin, lemon and orange) is the dominant tree crop. Small areas are used for growing mango, macadamia and tea tree.

Limitations to crop production are moderate and include climate (c_2-c_3) and water availability (m_3). Local climatic conditions are moderate for citrus, persimmon, custard apple and macadamia, but more favourable (minor) for pineapple, papaw, lychee and passionfruit. The texture profile of soils is loamy to moderate depth, resulting in a moderate soil water availability limitation. Areas with **Valetta** soil adjacent to Water Park Creek have been assigned a moderate flooding limitation.

Class 3 land with moderate limitations suitable for persimmon, citrus, custard apple, papaw, lychee, macadamia, carambola and passionfruit (Byfield only)

Pineapple has been excluded from this crop group (restricted to the Byfield area), because of either rockiness, water erosion or soil water availability limitations. **Raven** soil has stone and cobble in the plough zone which severely restricts the use of infrequent tillage on this land. **Broughton** soil has a very thick sandy surface horizon resulting in a severe (m_4) soil water availability limitation for pineapple production under dryland conditions. A small area of land with **Flanders** soil has a severe (e_4) water erosion limitation for pineapple production. The soils of this land class have a moderate (m_3) soil water availability limitation for tree crops.

The land is largely used for grazing beef cattle on native pastures. However, a few highly productive orchards growing lychee, longan and citrus on **Raven** soil occur in this unit. Pasture improvement associated with **Broughton** soil has been unsuccessful due to very low fertility and plant available water. Successful pasture production (mainly Rhodes grass and stylos) is associated with **Raven** soil of high fertility and adequate plant available water. Mandarin is the major tree crop. Some mango, avocado and banana crops are also grown.

Class 3 land with moderate limitations suitable for pineapple (Tanby only)

All other plantation, tree and vine crops are excluded because of low plant available water and impeded drainage conditions for these crops. Soil surface thickness over much of this land ranges from 0.3 to 0.5 m (unmounded) and is considered adequate for pineapple production. The dominant soils are **Rosslyn** and **Tanby** with minor occurrences of **Doonside**. Subsoil colour ranges from red through brown to grey, however the upper clay subsoils have similar chemical properties with high exchangeable magnesium (30-53% of the effective cation exchange capacity) and high exchangeable aluminium (>50%). Abrasiveness of the ironstone gravel presents a minor (k_2) soil workability limitation. Slopes are gentle (3-8%) with a moderate (e_3) water erosion limitation. The land is currently used for dryland and irrigated pineapple production.

Class 4 land with severe limitations marginal for fig, persimmon, citrus, stonefruit, custard apple, avocado, papaw, lychee, mango, carambola and passionfruit

This land is marginal for a wide range of crop types and unsuitable for macadamia and pineapple. Macadamia has been excluded from this crop group because a loose surface of fine grain sand presents an extreme limitation for mechanical harvesting of macadamia nuts. An extreme wind erosion and severe soil water availability limitations apply for pineapple production. **Kinka** soil, although deep and

rapidly drained has a severe (m_4) soil water availability and wind erosion limitation (a_4) for this crop group. The land is currently used for grazing, recreation and sand extraction

Class 4 land with severe limitations marginal for fig, persimmon, citrus, stonefruit, custard apple, papaw, lychee, mango, carambola and passionfruit

Avocado has been excluded from this crop group because of moderate soil depth on sloping land and restricted drainage on flat land. Pineapple has also been excluded due to the water erosion hazard, rockiness or wetness restrictions. The soils are **Beecher**, **Stevens**, **Beaks** and **Plain.**

No horticultural crops are currently grown on this land. Some areas with steep slopes were previously used for pineapple production. The land is used for grazing beef cattle on native, volunteer and improved pastures. Improved pastures include Rhodes grass, green panic and stylos.

Moderately steep land (15-20%) with **Beecher** and **Stevens** soils is marginal for this crop group because a of severe (ts_4) slope limitation for the safe use of machinery, and a severe (e_4) water erosion limitation. **Beaks** soil was assigned a severe (m_4) soil water availability limitation, as the soil is shallow to moderately deep. A slightly elevated area of flat land with **Plain** soil is marginal because of combined frost, flooding and wetness limitations.

Class 4 land with severe limitations marginal for fig, persimmon, citrus, stonefruit, lychee, mango, carambola and passionfruit

Very gravelly often cobbly red to brown soils are dominant in this land unit. These are **Coorooman**, **Cobbleton**, **Ruby** and **Doonside**. Much of the associated landform comprises gently sloping rises and footslopes. The unit also includes a gently sloping area with **Farnborough** soil. Avocado, custard apple and papaw are not included in this crop group as the minimum depth of soil drainage is inadequate for these crops. Macadamia and pineapple are excluded because most land has an extreme rockiness limitation for these crops.

The land is used mostly for grazing beef cattle on native pasture. Some areas have been sown with an improved pasture mix of Rhodes grass, setaria and stylos, and this has shown little improvement over native species. Small areas are cropped with mangoes and pineapples.

Limitations to crop production are severe. These are water availability (m_4) or wetness (w_4). **Coorooman**, **Cobbleton**, **Ruby** and **Doonside** have low plant available water and will require frequent irrigation to maintain optimum growth and production. The low lying area with **Farnborough** soil has a severe wetness limitation.

Class 4 land with severe limitations marginal for persimmon, citrus, custard apple, papaw, lychee, carambola and passionfruit (Byfield only)

Deep sands and texture contrast soils with a very thick sandy surface represent this land class. The soils are **Austins**, **Military**, **Simpsons** and **Keeley**. All occur on gently sloping topography adjacent to Water Park Creek. Avocado, grape, fig, mango and stonefruit are excluded as climatic conditions at Byfield are unfavourable for these crops. Macadamia and pineapple are also excluded because of the harvesting difficulty and wind erosion hazard associated with a loose sandy soil surface. The land is used mainly for grazing and some small areas are used for recreation and citrus. The most severe limitation for crop production with this restricted crop group is soil water availability. Some areas have a moderate flooding limitation.

Class 4 land with severe limitations marginal for persimmon, citrus, lychee, macadamia, carambola and passionfruit (Byfield only)

This Byfield land category has a slightly more restricted crop group than the above category. In comparison, macadamia is included but custard apple, papaw and pineapple are excluded. The soils of this land class are **Arnolds**, **Yaxley** and **Henson**. All are texture contrast with a very thick bleached sandy or loamy surface horizon overlying a slowly permeable clay subsoil. The landform is essentially flat and the soils are seasonally saturated.

Major land uses are grazing, rural-residential and areas of vacant freehold land. With reference to horticulture, a small area is used for mango and macadamia. The land is marginal for potential and current cropping because of soil water availability and wetness limitations. The soils have a moderate or severe (m_3-m_4) soil water availability limitation and all have been assigned a severe (w_4) wetness limitation.

Class 4 land with severe limitations marginal for pineapple

Land, marginal only for pineapple, occurs extensively throughout the Yeppoon area from Emu Park to Byfield. Impeded drainage conditions and low soil water storage determined by a shallow rooting depth present extreme limitations for all other plantation, tree and vine crops. The soils are characteristically texture contrast with loamy or clay loamy surface horizons overlying sodic or magnesic subsoils or subsoils with high exchangeable aluminium. The major soils are **Keppel**, **Tanby, Stanage, Awoonga** and **Rosslyn**.

Pineapples are grown extensively under dryland conditions on this land class at Tanby and Bungundarra. Some pineapple and cucurbit crops (zucchini, watermelon and pumpkin) at Tanby are grown with irrigation. Elsewhere, the land is almost entirely used for grazing and rural-residential uses, and includes former pineapple plantation areas now out of production. Sown pastures recorded in this unit include Rhodes and pangola grass, setaria, millet and stylos. These are grown with phosphatic fertilisers and some pastures are mown for hay.

The most severe limitation for pineapple production on this land is wetness. Generally, the soils have a surface thickness of 0.3 m (unmounded) which is considered adequate for drainage under normal rainfall conditions. However, during prolonged wet conditions, damage to the plant root system occurs and a severe (w_4) wetness limitation applies. The hardsetting gravelly abrasive soils **Keppel** and **Awoonga** have a moderate (k_3) soil workability limitation. Some low lying areas have a moderate (cf_3) frost limitation for pineapple.

Class 5 land unsuitable for plantation, tree and vine crops

This unit comprises very gravelly or stony soils on steep hills and steep rises, thin surfaced texture contrast soils on gently undulating rises, deep sands on beach ridges and remnant sand plains, hardsetting texture contrast and heavy clay soils in drainage lines and on plains. Some areas are strongly dissected with deep erosion gullies. Others have been excavated or are affected by tidal influence. A large number of soils (23) are specific to this unit. Other soils which occur in this unit have extreme limitations, or combined limitations which in aggregate are extreme.

The land is largely used for grazing beef cattle on native, volunteer and sown pastures. Setaria is a common sown pasture species in drainage lines and on plains. Stony rises and steep hillslopes have been broadcast (over sown) with Rhodes grass and stylos. The very steep slopes of the Coast Range including Mt Barmoya, Mt Rae, Mt Lizard and Grays Hill, remain largely as forest. Rural-residential use on small blocks is a significant land use type. Pineapples are grown on strongly dissected rises near Yeppoon. Small areas of mango, custard apple and avocado are grown on steep hillslopes throughout the unit.

Coorooman, **Gayfield**, **Raven**, **Darts**, **Blarney**, **Doonside** and **Lizard** soils on steep slopes (>20%) have an extreme (e_5) water erosion and slope limitation (ts_5) for the safe use of machinery. Areas with **Montrose**, **Newby**, **Tanby**, **Conway**, **Keppel**, **Rosslyn** and **Newen** have shallow depth to a sodic or magnesic clay subsoil with a severe (w_4) wetness limitation, and very low plant available water capacity with an extreme (m_5) soil water availability limitation. Soils of fine sand texture (**Selina**, **Mulambin** and **Kellys**) have complex topography with severe (a_4) wind erosion and soil water availability (m_4) limitations.

Poorly drained soils in water gathering sites with cemented hardpans (**Magnan** and **Paddys**) have an extreme (w_5) wetness limitation. Sodic or magnesic texture contrast soils in drainage lines and on plains (**Yaringa**, **Yeppoon**, **Teralba** and **Lorna**) have impeded drainage with a severe or extreme (w_4-w_5) wetness limitation, and an extreme (m_5) soil water availability limitation. Heavy clay soils with high water retention in drainage lines and on plains (**Cottons**, **Ironport**, **Plain**, **Cassandara** and **Ashen**) have an extreme (w_5) wetness limitation. Saline clays of tidal flats (**Tilden** and **Hoogly**), and deep erosion gullies with **Ruby** soil are precluded.

4. Built Infrastructure Limitations

Land which is unsuitable or marginal for agricultural use, in particular horticulture, can present problems or limitations for built infrastructure. Some of the limitations are obvious, such as steep hills or swampy depressions while others including acid sulfate or dispersible subsoil are less apparent. The effects of limitations can be reduced but the limitations themselves will remain, due to the inherent characteristics of the land. A large proportion of the survey area contains limitations to built infrastructure as about 86% or 44 500 ha was assessed as unsuitable or marginal land for horticultural use. The limitations described in this section are acid sulfate soils, dispersible subsoil, drainage, land slope, shrink-swell potential and salinity.

Acid sulfate soils.

These are soils which contain sulfides or an acid producing soil layer as the result of the oxidation of sulfides. They generally occur on low lying coastal land at elevations less than 5 m in height and are usually contained in saturated soil. When exposed to air, sulfides oxidise to produce sulfuric acid. Drained land can release acid, aluminium, iron and heavy metals affecting aquatic plants and animals. Infrastructure including pipes, foundations, house slabs and bridges are susceptible to acidic corrosion, leading to accelerated structure failure (Ahern *et al.* 1998).

Soils with an extreme potential acid sulfate hazard (Total Potential Acidity >1000 moles of hydrogen per tonne of soil) were recorded in the Calliope and Yeppoon areas. They occur in units on the accompanying soil maps as soils of tidal flats and are represented by **Tilden** soil. The potential acid sulfate hazard associated with **Hoogly** soil on slightly elevated land is unknown. Sampling indicates the likely occurrence of acid sulfate soils on low lying coastal land from Tannum Sands to Corio Bay.

Sampling at Cattle Creek inlet off the Boyne River provides an indication of the magnitude and variability of the potential acid sulfate hazard. Estuarine clay overlain by local sandy alluvium had total potential acidity values ranging from 461 to 894 moles of hydrogen per tonne of soil at 1.2 to 1.5 m depth. Adjacent mangrove mud was measured with much higher potential acidity (1174 moles of hydrogen per tonne of soil) at shallower depth (0.4 to 0.6 m). Estuarine clays and salt pans at South Trees Inlet, north west of Cattle Creek, have total potential acidities of 1519 to 1962 units at 0.2 to 0.3 m depth, and some areas have higher values to 2236 units at 0.9 to 1 m depth.

Tidal flats west of Causeway Lake, Yeppoon and south of Statute Bay (sites 451 and 567, Appendix II) have total potential acidities of 1458 and 1674 at relatively shallow depth 0.3 to 0.6 m. Sampling outside the survey area near Yeppoon indicates the presence of acid sulfate soils in swamps, incised drainage lines on beach ridge plains, and in beach ridge swales backfilled with estuarine sediments.

Dispersible subsoil.

Clay dispersion occurs when water is added to soils which have significant levels of exchangeable sodium or sodium and magnesium. The level of exchangeable calcium present influences the likelihood of dispersion as does the content of silt sized particles. Soil horizons with an exchangeable sodium percentage of 6 or more (sodic), or a calcium to magnesium ratio of less than 0.5 are potentially dispersible (Baker and Eldershaw 1993).

Some soils with a clay texture profile or a clayey subsoil can break down into fine particles (sand, silt and clay) which are easily moved by water or wind. Dispersed clay separated by water blocks soil pores reducing water entry, drainage, and increases the potential for waterlogging, runoff and erosion (Photo 4). Exposed subsoils provide a poor medium for the establishment of gardens and lawns, are

difficult to rehabilitate, and can lead to excessive sedimentation of adjacent water bodies. Excavated material with high dispersibility has limited suitability for earth construction purposes. Subsoil dispersion on sloping land can result in gully or tunnel erosion with preferential water movement.

A large number of soils throughout the survey area have clay subsoils with magnesium as the dominant exchangeable cation, a significant level of exchangeable sodium and a low level of exchangeable calcium. These fall into a number of soil groups of which sodosols are a major group. Texture contrast soils with a significant level of exchangeable sodium in the upper clay subsoil are termed sodic and shown on the accompanying soil maps as sodosols. Nineteen soils classified as sodosols occur in the Calliope area and ten in the Yeppoon area. These soils are associated with rises predominantly on sedimentary rocks, drainage lines, plains and higher river terraces. Other soil groups in the survey area have sodic or magnesic properties but are not sodosols. These soils will be dispersible. An example is the **Larcom** soil, a brown vertosol (see Section 5.6).

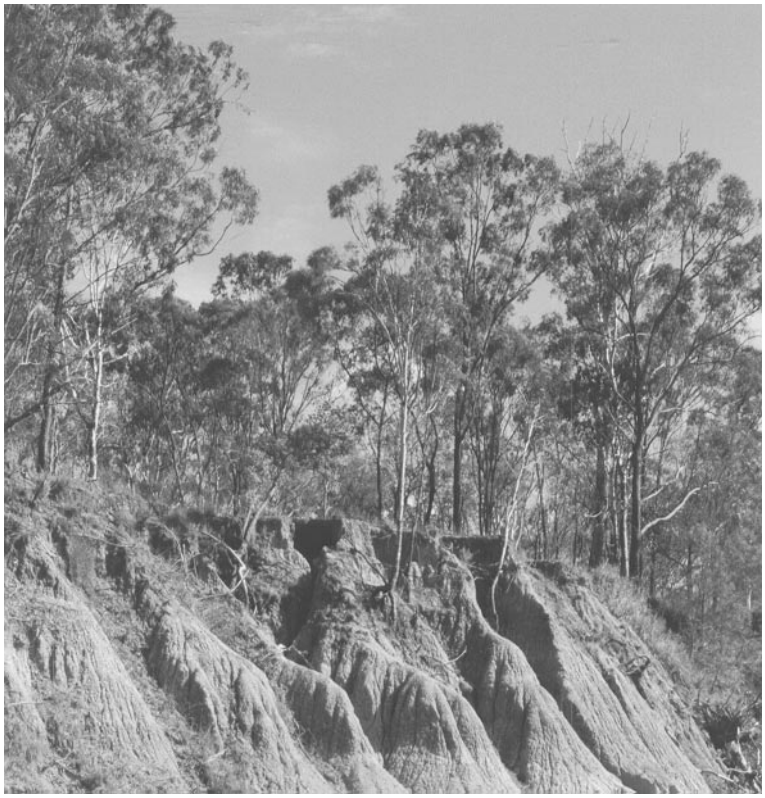

Photo 4. Highly dispersible subsoil, Boyne River alluvium

Drainage.

This is the removal of surplus water from the surface or below the surface of land to create favourable conditions for habitation. Surplus water can be removed by raising the land surface, constructing open or covered drains, or by pumping where gravity flow is restricted. Drainage problems often affect a number of contiguous properties.

Construction costs and suitability for urban development are influenced by the amount of excavation required for drainage and the feasibility of drainage discharge by gravity to nearby streams. Urban development alters drainage patterns, reduces infiltration and increases storm-water runoff. Areas of

poorly drained land are often left undeveloped. For rural-residential development, soil profile drainage can determine the suitability of an area for on-site septic tank disposal.

Areas of seasonally wet soils associated with lower slopes, drainage lines, depressions and plains occur throughout the survey area. Excluding tidal land, only a few sites had soils classified as Hydrosols (Isbell 1996), and since much of the survey area has experienced below average rainfall from 1991 to 1998, their occurrence may have been underestimated. Some soils were recorded with seasonal perched water tables above clay subsoils, and drainage problems can be inferred for others from profile features.

At Byfield, Tanby and Bungundarra, soils with thick sandy or loamy surface horizons and slow surface drainage, overlying slowly permeable clay subsoils were observed with seasonal perched water tables. The soils are **Arnolds**, **Yaxley**, **Teralba** and **Stanage**. Throughout the survey area, soils with a cemented subsurface horizon (**Newby**) and those overlying cemented hardpans (**Magnan**, **Paddys**, **Newen** and **Mulambin**) also have seasonally perched water tables. Clay soils in closed depressions or swamps (**Narva** and
Ironport) have reducing conditions at shallow depth and free standing surface water. Natural drainage lines at the base of steep hills have eroded to depths of up to 6 m. They are represented by **Ruby** soil and will pose special problems for development.

Land slope.

Steep land (generally >20% slope) is unfavourable for development as the costs of roads and buildings are increased because of the amount of excavation and stabilisation required. There is increased difficulty in service provision and potential for traffic hazard. At some point these difficulties become so severe as to preclude development. Excessive land slope excludes certain uses, for example sporting fields, which require relatively flat land.

Throughout the survey area there is a high proportion of steeply sloping land, occasionally fragmented, and separated by areas of comparatively level land. Areas of gently undulating land are limited in extent. The topography of the Calliope area is characterised by narrow valley floors rising abruptly to steep low hills and steep hills of the Boyne and Mount Larcom Ranges. Soils of the area commonly associated with steep land are **Coorooman**, **Darts**, **Muldoon**, **Beaks** and **Gayfield**. The Yeppoon area has similar topography with areas of relatively level land surrounded by areas of steeply sloping land. Footslopes associated with steep hills of the Coast Range, including Mt Barmoya, Mt Rae, Mt Lizard and Grays Hill, are larger in extent. **Coorooman**, **Beaks**, **Darts**, **Gayfield** and **Raven** soils, mainly occur on steep land within the Yeppoon area.

Shrink-swell potential.

Some soils, particularly cracking clays, have the capacity to significantly change in volume with changing moisture conditions. The shrinking / swelling characteristic is largely due to the presence of smectite clay minerals in the soil profile. Expansive clay soils cause instability in building and road foundations. Walls and foundations crack in the absence of special reinforcement. Driveways, footpaths and streets can deteriorate more quickly.

A clay activity ratio (Ratio of CEC to clay) of >0.8 indicates the dominance of smectite clay minerals in expanding clay soils (Baker and Eldershaw 1993). Clay activity ratios for heavy cracking clay soils in the survey area range from 0.5 to 0.8, indicating the presence of a range of clay minerals. Soils within this range were found to shrink to large blocks rather than to small structural units (Ross and

Crane 1994). Laboratory measurement (linear shrinkage) is used to determine the level of shrink-swell potential.

Cracking clay soils are more common in the Calliope area, particularly near the existing Calliope urban area and on the high terrace of the Calliope River. A high shrink-swell potential is inferred for **Cassandara**, **Ashen**, **Larcom, Marla** and **Narva** soils, based on surface cracking, high clay content, lenticular structure and surface gilgai. This conclusion needs to be confirmed by laboratory measurement and for other soils with lenticular subsoil structure and surface gilgai.

***Salinity*.**

Salt affected land in lower landscape positions can be attributed to tree clearing on upper slopes, or to the excess application of water to soils with poor drainage and inherently saline subsoils. A rise in the local water table brings salt laden water closer to the surface where evaporation results in the concentration of salt at the surface. Salinity in urban areas can affect the establishment and growth of lawns, gardens and trees.

Excluding tidal land, there was no recorded occurrence of salinity in the Calliope survey area. Soil salinisation occurs at a number of locations throughout the Yeppoon survey area, under dryland conditions. Although the areas are not large in extent they will present problems with changing land use. Salinity occurs in some lower landscape positions along Ross, Daly and Limestone Creeks, in drainage lines adjacent to the Rockhampton-Yeppoon Road, below dams in the Lake Stevens area and on a lower slope and plain in the Mt Lizard area.

The soils associated with these salt affected areas are **Teralba**, **Yaringa**, **Yeppoon** and **Stanage**. All have a texture contrast profile and impeded drainage. The salt profile of these soils typically has a high concentration (electrical conductivity 2 to 4 dS/m) at the soil surface, and a very low concentration of salts below 0.1 m depth and continuing low to below 1.5 m depth.

5. Soils

Ninety three soils were recognised throughout the survey area. Twenty six of these occur in both the Calliope and Yeppoon areas while the distribution of the remaining soils have specific landform or parent material locations not common to both areas. The soils were mapped as separate units at soil profile class level (Isbell 1988), using a free survey technique (Reid 1988). Mapping units are named after the dominant soil. The soil mapping units frequently contain more than one soil type, and the relative proportion of the soils (up to three) in any mapped area is shown in the UMA database.

The soils have been given names to allow representation of important soil characteristics which in formal soil classification schemes would be less apparent. They are classified according to A Factual Key (Northcote 1979) and to family level in The Australian Soil Classification (Isbell 1996). Soil terminology follows the Australian Soil and Land Survey Field Handbook (McDonald *et al.* 1990).

Soils with uniform, gradational and texture contrast profiles occur, several have gravelly surface horizons and most have acid subsoils. Some soils have high exchangeable sodium, magnesium or aluminium, and most have low fertility and low nutrient retention characteristics. Data for soil descriptions and chemical analyses of 40 profiles are tabulated in Appendix II and are referenced by site number in the following text. Chemical data from selected sampling mainly of the upper clay subsoil or subsoil of a range of soils is contained in interim reports (Ross 1996a-g, 1977a,b). The soils have been grouped according to topography and parent material. A general description of the soils, their associated parent material, distribution and important chemical properties are given below.

5.1 Soils of Hills and Rises on Sedimentary Rocks and Metasediments

This soil group occurs over a range of landforms from gently undulating rises (slopes 2 to 5%) to steep low hills (slopes >30%). The underlying geology mostly comprises the Doonside, Wandilla and Shoalwater formations collectively named as the Curtis Island Group (Willmott *et al.* 1986). Common lithologies are sedimentary rocks including chert, mudstone, siltstone and sandstone. Some of the rock types have undergone structural, physical and chemical changes and the resulting rocks are referred to as metasediments. Associated soils are either uniform, gradational or texture contrast in profile form.

Table 1. General description, classification and occurrence of soils

SOILS OF THE HILLS AND RISES ON SEDIMENTARY ROCKS AND METASEDIMENTS

Uniform loams and clay loams

Darts	Shallow very gravelly brown or dark loamy soil; occasional rock outcrop	Bleached-Leptic Tenosol	Calliope, Yeppoon
Blarney	Shallow gravelly bleached loamy soil	Bleached-Leptic Tenosol	Yeppoon
Morven	Shallow gravelly brown clay loamy soil; occasional rock outcrop	Leptic Tenosol	Yeppoon

Gradational soils

Coorooman	Very gravelly sandy or loamy surface grading to a gravelly brown or red massive clay loamy subsoil; occasional rock outcrop	Brown or Red Kandosol	Calliope, Yeppoon
Cobbleton	Cobbly loamy surface grading to a gravelly red massive clay subsoil; occasional stone	Red Kandosol	Calliope, Yeppoon
Beecher	Gravelly clay loamy surface grading to a red massive clay subsoil	Red Kandosol	Calliope, Yeppoon
Elizabeth	Clay loamy surface grading to a red massive clay subsoil	Red Kandosol	Calliope, Yeppoon
Lizard	Clay loamy surface grading to a red structured clay subsoil; occasional gravel	Red Ferrosol	Calliope, Yeppoon
Farnborough	Clay loamy surface grading to a yellowish brown clay subsoil	Brown Dermosol	Yeppoon

Texture contrast soils - red subsoil

Doonside	Gravelly loamy or clay loamy surface over red clay subsoil; occasionally bleached	Red Chromosol	Calliope Yeppoon
Conway	Gravelly loamy surface over mottled red clay subsoil	Red Kurosol or Red Sodosol	Calliope, Yeppoon
Barrack	Clay loamy surface over red clay subsoil	Red Chromosol	Yeppoon
Bayfield	Loamy surface with pale yellow subsurface over mottled red clay subsoil	Red Kurosol	Yeppoon

Texture contrast soils - yellow brown subsoil

Keppel	Gravelly bleached clay loamy surface over acid mottled yellowish brown sodic clay subsoil	Brown Sodosol	Calliope, Yeppoon
Newby	Gravelly bleached clay loamy surface with cemented subsurface over mottled yellowish brown sodic clay subsoil	Brown Sodosol	Calliope, Yeppoon
Awoonga	Gravelly bleached clay loamy surface over alkaline mottled brown sodic clay subsoil	Brown Sodosol	Calliope, Yeppoon
Ebon	Gravelly black clay loamy surface over alkaline yellowish brown clay subsoil	Brown Chromosol	Yeppoon
Todds	Loamy surface with pale yellow subsurface over mottled yellowish brown clay subsoil	Brown Chromosol or Brown Kurosol	Yeppoon
Liston	Loamy surface with very thick yellow subsurface over mottled yellowish brown clay subsoil	Yellow Kurosol	Yeppoon
Hensen	Thick bleached loamy surface over mottled yellow clay subsoil	Yellow Chromosol	Yeppoon

Texture contrast soils - grey brown subsoil

Sable	Gravelly black clay loamy surface over greyish brown clay subsoil	Grey Chromosol	Yeppoon
Rosslyn	Gravelly bleached clay loamy surface over acid mottled grey sodic or magnesic clay subsoil	Grey Sodosol or Grey Kurosol	Yeppoon
Tanby	Gravelly bleached loamy surface over acid mottled grey magnesic clay subsoil	Grey Kurosol	Yeppoon
Montrose	Bleached silty surface over alkaline greyish brown sodic clay subsoil	Brown Sodosol	Yeppoon
Stanage	Thick bleached loamy or sandy surface over acid mottled grey magnesic clay subsoil	Grey Kurosol	Yeppoon
Keely	Very thick bleached sandy surface over mottled grey clay subsoil; occasional dark brown hardpan	Grey Kurosol	Yeppoon

SOILS OF RISES ON LIMESTONE

Cammoo	Stony clay loamy surface grading to a red structured clay subsoil	Red Dermosol	Calliope

SOILS OF HILLS AND RISES ON GRANTITIC ROCKS AND SEDIMENTS

Uniform or gradational soils

Gayfield	Stony loamy brown soil; occasional rock outcrop	Leptic Tenosol	Calliope, Yeppoon
Raven	Black loamy soil; occasional stone and boulder	Chernic-Leptic Tenosol	Yeppoon
Meilland	Coarse sandy or loamy surface grading to a red or brown clay loamy subsoil or coarse sandy throughout	Red Kandosol or Orthic Tenosol	Calliope, Yeppoon
Carmine	Loamy or clay loamy surface grading to a red clay subsoil	Red Kandosol	Calliope
Iveragh	Bleached coarse sand over cemented hardpan or granite	Bleached-Leptic Tenosol	Calliope

Texture contrast soils

Stoneleigh	Stony clay loamy surface over red clay subsoil	Red Chromosol	Calliope
Swans	Sandy or loamy surface over mottled brown clay subsoil	Brown Chromosol	Calliope
Flanders	Very thick loamy surface with pale yellow subsurface over mottled grey clay subsoil	Grey Kurosol	Yeppoon
Broughton	Very thick sandy surface with pale yellow subsurface over mottled grey clay subsoil	Grey Kurosol	Yeppoon
Yaxley	Very thick loamy surface with bleached subsurface over mottled grey clay subsoil	Grey Kurosol	Calliope, Yeppoon
Arnolds	Very thick sandy surface with bleached subsurface over mottled grey clay subsoil	Grey Kurosol	Yeppoon
Voewood	Loamy surface with bleached subsurface over alkaline mottled grey or brown sodic clay subsoil	Grey or Brown Sodosol	Calliope

Newen	Bleached loamy surface over alkaline mottled brown clay subsoil; cemented hardpan below 0.5m	Brown Sodosol	Yeppoon

SOILS OF HILLS AND RISES ON VOLCANIC ROCKS

Beaks	Gravelly loamy surface grading to a gravelly brown or red clay loamy massive subsoil	Brown Kandosol	Calliope, Yeppoon
Muldoon	Shallow to moderately deep, gravelly clay loamy or clayey surface grading to a red or brown structured clay subsoil	Red or Brown Dermosol	Calliope
Stevens	Gravelly dark clay loamy surface over red clay subsoil	Red Kurosol	Yeppoon

Texture contrast soils

Boyles	Gravelly clay loamy surface over brown or yellowish brown clay subsoil	Brown Chromosol	Calliope
Yarwun	Gravelly clay loamy surface with bleached subsurface over yellowish brown sodic clay subsoil	Brown Sodosol	Calliope

Uniform clays

Shingle	Cobbly black clayey surface with red clay subsoil	Red Dermosol	Calliope
Bompa	Shallow to moderately deep brown or black clay; occasional rock outcrop	Brown or Black Dermosol	Calliope

SOILS OF DRAINAGE LINES, CREEK TERRACES AND PLAINS

Uniform sands

Military	Grey brown sandy surface over yellow brown sand	Orthic Tenosol	Yeppoon
Austins	Thick bleached sandy surface over brown sand	Aeric Podosol	Yeppoon

Uniform loams and clay loams

Valetta	Loamy surface with brown or red loamy subsoil	Orthic Tenosol	Calliope, Yeppoon

Magnan	Clay loamy or silty surface over grey cemented manganiferous hardpan	Bleached-Leptic Tenosol	Calliope, Yeppoon
Lidon	Clay loamy surface with bleached subsurface, over buried soils	Bleached-Leptic Tenosol	Yeppoon

Gradational soils

Ruby	Gravelly clay loamy surface grading to a gravelly red or brown clay subsoil	Red or Brown Kandosol	Calliope, Yeppoon
Corduroy	Clay loamy surface grading to a dark structured clay subsoil	Black Dermosol	Calliope, Yeppoon
Paddys	Thick bleached dilatant surface over grey cemented hardpan	Bleached-Leptic Tenosol	Yeppoon

Texture contrast soils

Dale	Clay loamy surface over brown clay subsoil, over buried soils	Brown Chromosol	Calliope
Kindara	Loamy surface over black sodic clay subsoil; normal gilgai	Black Sodosol	Calliope
Adsett	Bleached sandy surface over mottled grey sodic clay subsoil; occasional hardpan or normal gilgai	Grey Sodosol	Calliope
Yeppoon	Bleached silty surface over acid mottled grey to brown clay subsoil	Grey Sodosol or Grey Chromosol	Yeppoon
Yaringa	Bleached silty surface over alkaline mottled grey to brown clay subsoil; occasional normal gilgai	Grey or Brown Sodosol	Calliope, Yeppoon
Lorna	Bleached clay loamy surface over yellowish brown clay subsoil	Brown Sodosol	Calliope, Yeppoon
Teralba	Thick loamy surface over grey to brown clay subsoil	Grey or Brown Sodosol	Calliope, Yeppoon
Simpsons	Very thick pale yellow sandy surface over brown clay subsoil	Brown Chromosol	Yeppoon

Uniform clays

Plain	Black non-cracking clay overlying grey clay and gravel	Black Dermosol	Yeppoon

Cottons	Deep black non-cracking clay; normal gilgai	Black Dermosol	Yeppoon
Ironport	Deep partly bleached grey non-cracking clay; normal gilgai	Grey Dermosol	Yeppoon
Cassandra	Deep black cracking clay; normal gilgai	Black Vertosol	Calliope, Yeppoon
Ashen	Deep grey cracking clay; normal gilgai	Grey Vertosol	Calliope, Yeppoon

SOILS OF RIVER TERRACES

Uniform sands and loams

Arnica	Brown sand over layered yellowish brown sand and water-worn gravel	Stratic Rudosol	Calliope
Berrigan	Black sandy surface with brown massive sandy subsoil, over water-worn gravel	Orthic Tenosol	Calliope
Boyanda	Black sandy surface with brown massive sandy subsoil	Orthic Tenosol	Calliope

Gradational soils

Benaraby	Black loamy surface grading to a brown massive clay loamy subsoil	Brown Kandosol	Calliope
Ceduna	Black loamy surface grading to a brown structured clay subsoil	Brown Dermosol	Calliope
Catalina	Black clay loamy surface grading to a brown structured clay subsoil, over buried soils	Brown Dermosol	Calliope

Texture contrast soils

Diglum	Black clay loamy surface over black clay subsoil	Black Chromosol or Black Sodosol	Calliope
Kenway	Dark loamy surface over brown sodic clay subsoil, over buried soils	Brown Sodosol	Calliope
Harwood	Dark loamy or clay loamy surface with bleached subsurface over yellowish brown sodic clay subsoil	Brown Sodosol	Calliope

Camona	Black loamy or clay loamy surface over mottled yellowish brown sodic clay subsoil	Brown Sodosol	Calliope
Dorall	Dark silty surface over mottled grey to brown sodic clay subsoil	Grey or Brown Sodosol	Calliope
Pitt	Bleached silty or loamy surface over mottled grey sodic clay subsoil; occasional hummocky microrelief	Grey Sodosol	Calliope
Sandralee	Thick sandy bleached surface over mottled greyish brown sodic clay subsoil	Grey Sodosol	Calliope
Stowe	Association of brown sodic texture contrast soils and brown cracking clays; normal gilgai	Brown Sodosol Brown Vertosol	Calliope

Uniform clays

Brooks	Dark non-cracking clay over buried soils	Black Dermosol	Calliope
Evander	Deep partly bleached greyish brown non-cracking clay; normal gilgai	Brown Dermosol	Calliope
Larcom	Deep brown cracking clay; normal gilgai	Brown Vertosol	Calliope
Marla	Deep dark cracking clay; normal gilgai	Black Vertosol	Calliope
Narva	Deep mottled grey cracking clay; hummocky microrelief	Aquic Vertosol	Calliope

SOILS OF BEACH RIDGES AND SAND PLAINS

Selina	Association of ridges with brown fine sand over yellow to brown fine sand, and swales with bleached fine sand over brown fine sand; alkaline substrate	Orthic Tenosol Aeric Podosol	Yeppoon
Kinka	Association of ridges with grey to brown fine sand over yellow to brown fine sand, and swales with bleached fine sand over brown fine sand; neutral or acid substrate	Arenic Rudosol Aeric Podosol	Calliope, Yeppoon
Kellys	Very thick bleached sandy surface over brown sand	Aeric Podosol	Yeppoon
Mulambin	Dark sandy surface with bleached subsurface over dark brown sand; hardpan or watertable below 1.5m	Semiaquic Podosol	Yeppoon

SOILS OF TIDAL FLATS

Tilden	Saline brown silty or clayey surface over mottled grey clay, over layered sulfidic clay	Supratidal Hydrosol	Calliope, Yeppoon
Hoogly	Dark or black clayey surface over mottled saline grey clay	Extratidal Hydrosol	Yeppoon

Uniform loams and clay loams

Darts soil is very gravelly, brown or dark in colour and has shallow depth to weathered or hard rock. The surface horizons are gravelly dark sandy loams or sandy clay loams with moderate fine subangular blocky structure. These grade to a paler subsurface horizon, often bleached, of similar texture and higher gravel content. Soil depth ranges from 0.15 to 0.5 m. Soil reaction trend is acid. Laboratory data (site 403, Appendix II) show 25% clay in the surface horizon increasing to 31% in the subsurface horizon. Cation exchange capacity is very low (<10 me%) throughout the profile with calcium being the dominant cation in the surface horizon. Levels of total nitrogen, available phosphorus and sulfur are low.

Blarney soil is distinguished from **Darts** by a paler surface horizon, thicker bleached subsuface horizon, lower gravel content and absence of rock outcrop. It has a restricted occurrence in the survey area north of Yeppoon. The surface horizons are greyish brown in colour, fine sandy loam in texture and hardsetting when dry. Conspicuously bleached subsurface horizons overly hard sedimentary rock at 0.4 to 0.6 m depth. Soil reaction trend is acid.

Morven soil has a restricted occurrence on sedimentary rocks and metasediments at Byfield. It has a uniform clay loamy texture profile overlying weathered rock at shallow depth (<0.4 m), and occasional rock outcrop. The soil surface horizons are gravelly greyish brown or dark greyish brown sandy clay loams 0.1 to 0.12 m thick. These grade to brown or pale brown subsurface horizons (occasionally bleached) of clay loam texture and high gravel content. A thin (<0.1 m) brown light clay massive subsoil can occur above weathered rock. Soil reaction trend is acid.

Gradational soils

Coorooman is a gradational loamy soil which occurs on the crests of steep hills and rises through moderate to steep sideslopes (20 - 40%). Gravel content is high and typically chert. The surface horizons are very gravelly, dark greyish brown or reddish brown loamy sands or sandy loams, 0.1 to 0.2 m thick. These are underlain by a paler brown subsurface horizon of loamy or clay loamy texture with high gravel content. There is a gradual change with depth to a brown or reddish brown massive subsoil of gravelly sandy clay loam or occasionally sandy light clay texture. The soil profile is moderately deep (0.4 to 0.9 m). Soil reaction trend is acid. Laboratory data (site 26) show very low cation exchange capacity in the surface and subsoil horizons. The levels of exchangeable calcium, magnesiun and potassium are below the levels of sufficiency for most agricultural crops (Baker and Eldershaw 1993).

The distinguishing feature of **Cobbleton** soil, from other red gradational soils, is the high content of cobble (coarse fragments 60-200 mm in size) in the surface horizons. Dark brown to dark reddish brown loamy or clay loamy surface horizons grade with depth to a reddish brown or red clay loamy or clayey massive subsoil. Soil reaction trend is acid. The soil is moderately deep (>0.7 m), and some surface stone (coarse fragments >200 mm in size) is usually present.

The gravelly red gradational soil, **Beecher**, is usually deep (>1.4 m) on lower hillslope positions and of moderate depth (1 m) on upper slope positions. The surface horizons are dark reddish brown clay loams with common coarse gravels (20 - 60 mm in size) and some cobble. The gravel and cobble is strongly manganese enriched at some locations. There is a gradual change at 0.15 to 0.3 m depth to a dark red light clay subsoil with some coarse gravels. The deep dark red clay subsoil is weakly structured and contains some manganese nodules and gravel. Soil reaction trend is acid. Laboratory data from selected sampling shows the upper clay subsoil to have very low cation exchange capacity (<5 me%) and low capacity for retention of added nutrients.

Elizabeth soil is a red gradational soil which has no gravel or a very small amount of gravel in the surface horizons. Low amounts of gravel usually occur in the clay subsoil below 0.5 m depth. The surface horizons are dark reddish brown clay loams with moderate or strong granular structure. There is a gradual change at 0.1 to 0.25 m depth to a dark red or reddish brown light clay subsoil. The texture of the subsoil gradually increases with depth and between 0.4 and 0.9 m there is a red light medium clay with weak polyhedral structure. Manganese nodules can occur in the surface horizon and throughout the deep subsoil. Soil reaction trend is acid. Laboratory data (sites 248 and 331) for this soil class shows 23 to 30% clay in the surface horizon increasing to 54% in the deep subsoil. Cation exchange capacity is very low in the clay subsoils, indicative of the deep weathering of parent materials. At site 331, the levels of exchangeable calcium and potassium are below the levels of sufficiency for most agricultural crops. Available phosphorus levels in the soil surface horizons are low at both sites.

Lizard soil is distinguished from similar deep red gradational soils (**Elizabeth** and **Beecher**) by the presence of a moderate or strong grade of structure throughout the soil profile. The surface horizons are up to 0.35 m thick and consist of dark reddish brown clay loam or light clay with moderate or strong granular structure. Manganese nodules and small amounts of fine gravel can occur in the surface horizon and in the deep red clay subsoil. Field textures appear less clayey than the percentage clay content would indicate (site 946). This is due to high free iron content (citrate-dithionite iron 8%) throughout the profile. Cation exchange capacity is very low indicating low nutrient retention and deep weathering.

The yellowish brown structured gradational soil **Farnborough** is the yellow to brown equivalent of **Lizard** soil. It occurs on lower slope positions in assocation with the deep red soils and in minor drainage areas within the **Lizard**, **Beecher** and **Elizabeth** map units. The dark clay loamy surface horizons are up to 0.4 m thick and have a moderate grade of polyhedral or cast structure. There is a gradual change to a yellowish brown or brown light clay or light medium clay subsoil with moderate polyhedral structure. The lower subsoil is either a red or mottled brown and red light medium clay. Manganese, iron-manganese and gravel occur throughout the deep clay subsoil. Soil reaction trend is acid. Laboratory data from selected sampling shows similar chemical properties to the associated deep red soils with low to very low (<8 to 4 me%) cation exchange capacity.

Texture contrast soils - red subsoil

Doonside, a red texture contrast soil, occurs on gently undulating rises to steep low hills. Surface horizons are gravelly brown to dark greyish brown loams or clay loams 0.15 to 0.2 m thick. These grade to a paler subsurface horizon (often bleached) of similar texture but usually with a higher gravel content. The surface horizons overlie a red clay subsoil which is moderately structured and contains some gravel. The deep lower clay subsoil is often grey in colour with prominent red mottles. Soil depth ranges from 0.7 to >1.5 m. Soil reaction trend is acid to strongly acid. Exchangeable aluminium in the clay subsoil is high (>50% of the effective cation exchange capacity) at some locations.

Conway is a red texture contrast soil, similar to **Doonside**, with a mottled upper clay subsoil and bleached subsurface horizon. The surface horizons can also be thicker (0.6 m) on lower hillslope

positions and very gravelly (90% gravel). Soil depth ranges from 0.6 to >1.5 m. Soil reaction trend is strongly acid. Laboratory analyses (sites 384, 412 and selected samples) show the clay subsoil to have very low exchangeable calcium and to be dominated by either exchangeable magnesium or aluminium. Cation exchange capacity ranges from 8 to 14 me%. The soil surface can have moderate to high (1.9 to 3.4%) organic carbon levels.

Barrack soil represents the non-gravelly structured texture contrast soils with a whole coloured red clay subsoil. The surface horizons are structured dark brown loams or fine sandy clay loams 0.1 to 0.3 m thick. These are underlain by a brown subsurface horizon of similar texture. At 0.15 to 0.45 m depth there is a clear change to a dark red light or medium clay subsoil. Some brown mottling and gravel may occur in the deep red clay subsoil. Soil depth ranges from 1.2 to >1.5 m. Soil reaction trend is acid. Chemical data from selected sampling show the soil to have very low cation exchange capacity (<5 me%) and consequent low nutrient retention.

The distinguishing physical features of **Bayfield** soil are a pale yellow subsurface horizon with very few gravels overlying a mottled red clay subsoil. The surface horizon is a greyish brown fine sandy loam 0.04 to 0.12 m thick. This grades to a yellow or pale yellow subsurface horizon of fine sandy clay loam texture. A low amount of medium rounded ironstone gravel is usually present. Below 0.22 to 0.5 m depth the red medium clay subsoil is moderately structured, mottled and contains some fine ironstone gravel. Soil depth ranges from about 1 m to >1.5 m. Soil reaction trend is strongly acid. Selected sampling in the Byfield district and laboratory data for site 587 show similar subsoil chemical properties to **Conway** soil (magnesium or aluminium > calcium). However surface soil fertility is different with much lower levels of exchangeable calcium, magnesium, available phosphorus and organic carbon.

Texture contrast soils - yellow brown subsoil

Keppel soil is the dominant soil on low rises throughout the survey area. Gravelly loamy or clay loamy surface horizons overlie bleached subsurface horizons of high gravel content. At <0.4m depth there is strong texture contrast to a yellowish brown medium clay subsoil with either grey or red mottles. The lower subsoil is usually a grey clay with either brown, red or yellow mottles. Soil depth ranges from 0.6 to > 1.5 m. Soil reaction trend is acid. Exchangeable sodium percentage in the upper clay subsoil of site 295 is 16%, and a range from 8 to 30% was measured for selected samples. Exchangeable magnesium frequently comprises 80% of the exchange complex. Cation exchange capacity is low to moderate.

Newby, a yellowish brown texture contrast soil, is distinguished from **Keppel** by the presence of a hardpan in the subsurface horizon. Brown to dark greyish brown clay loamy surface horizons 0.1 to 0.25 m thick overlie gravelly bleached subsurface horizons of similar texture. These are underlain by a cemented manganiferous hardpan at 0.25 to 0.35 m depth. The mottled yellowish brown medium clay subsoil grades with depth to a grey medium heavy clay with yellow mottles. Soil reaction trend is acid or neutral.

The alkaline equivalent of **Keppel** soil is called **Awoonga**. Gravelly clay loamy surface horizons overlie bleached subsurface horizons of high gravel content. At 0.22 to 0.38 m depth, the texture change is abrupt to a yellowish brown medium or medium heavy clay subsoil, with grey or red mottles. Soil depth ranges from 0.7 to >1.5 m. Exchangeable sodium percentage in the upper clay subsoil of site 1019 is 23%, increasing to 45% at 1.2 m depth. A range from 6 to 25% was measured for selected upper clay subsoil samples.

The surface horizon of **Ebon** soil is characteristically black, moderately or strongly structured and clay loamy in texture. Low to moderate amounts of coarse gravel (20 - 60 mm in size) occur in the surface and dark subsurface horizons. At 0.35 to 0.45 m depth the dark yellowish brown medium clay subsoil is moderately structured and contains some red mottles. The lower clay subsoil is paler

with distinct grey mottles. Soil reaction trend is alkaline. Cation exchange capacity is moderate for this soil (site 543). The upper clay subsoil is non-sodic while the lower subsoil is sodic below 0.8 m depth. The soil surface horizon has a high level of organic carbon and total nitrogen.

Todds soil has a thick pale yellow subsurface horizon overlying a mottled yellowish brown clay subsoil. The surface horizon is massive, greyish brown in colour and fine sandy loam in texture. This grades to a pale yellow subsurface horizon, partly bleached, of fine sandy loam texture increasing to fine sandy clay loam. At 0.5 to 0.75 m depth there is strong texture contrast to a yellowish brown medium clay with distinct red mottles. The lower clay subsoil is either brown or grey with red or yellow mottles. Soil depth exceeds 1.5 m. Soil reaction trend is acid or strongly acid. Cation exchange capacity of the upper clay subsoil is low to very low (8 to 4 me%). Laboratory analyses for selected samples also show exchangeable calcium to be acutely deficient in this soil.

Liston soil has similar features to **Todds**, but has a much thicker (>0.9 m) soil surface. The surface horizons are greyish brown fine sandy loams grading to thick yellow subsurface horizons of fine sandy loam texture increasing to fine sandy clay loams with depth. The subsoil below 1 m is a yellowish brown medium clay with distinct red mottles. Soil reaction trend is strongly acid. Cation exchange capacity of the clay subsoil is low to very low (7 to 4 me%). Magnesium and aluminium are the dominant cations.

A thick bleached loamy surface and mottled yellow clay subsoil are distinguishing features of **Henson** soil. Greyish brown or dark greyish brown surface horizons of fine sandy loam texture overlie bleached subsurface horizons of fine sandy loam or less commonly fine sand texture. At 0.7 m depth the texture change is abrupt to a yellow or brownish yellow medium clay subsoil with red mottles. Below 1 m depth there is a gradual change to a grey medium clay lower subsoil with prominent red mottles. Soil reaction trend is acid. The clay subsoil has low cation exchange capacity and exchangeable magnesium is dominant.

Texture contrast soils - grey brown subsoil

A black structured clay loam surface overlying greyish brown clay are distinguishing features of **Sable** soil. Moderate amounts of coarse gravel (20 - 60 mm in size) occur in the surface horizon and deep subsoil. At 0.3 to 0.4m depth the greyish brown medium clay subsoil is moderately structured and contains some yellow mottles. The lower clay subsoil is greyer with distinct yellow mottles. Soil reaction trend is alkaline. Cation exchange capacity is moderate in the soil surface (32 me%), decreasing to 22% in the clay subsoil. The upper clay subsoil is non-sodic while the lower subsoil is sodic (10% exchangeable sodium) below 0.7 m depth.

Rosslyn represents the class of hardsetting acid grey texture contrast soils which predominantly occur on lower hillslope positions above drainage lines and has some similarities with the yellow brown texture contrast soil **Keppel**. A wide range of soil properties have been recorded for the **Rosslyn** soil class. The surface horizon texture is loamy or clay loamy with or without gravel. The paler subsurface horizon is bleached or partly bleached. However, the surface horizons are moderately thick (0.3 to 0.5 m). The medium clay subsoil is greyish brown in colour at slightly better drained locations and mottling is usually absent. Soil depth ranges from 0.6 to >1.5 m. Laboratory analyses show Rosslyn soil to have very low cation exchange capacity (< 8 me% for site 968), and for exchangeable magnesium to comprise 85% of the subsoil cations.

Tanby soil is dominant on gently undulating and strongly dissected low rises west of the Tanby Range. The soil surface horizons are firm, greyish brown in colour, typically sandy loam in texture, and contain high amounts of medium rounded ironstone gravel (8 to 15 mm in size). Texture increases in the gravelly bleached subsurface horizon to sandy clay loam. At 0.15 to 0.5 m there is an abrupt textural change to a grey medium heavy clay subsoil with red and yellow mottles. Soil reaction trend is acid or strongly acid. Laboratory analyses from cropped land (site 455), show the marked

clay increase (3 fold) between surface and subsoil horizons and the dominance of aluminium and magnesium in the clay subsoil.

Silty textured surface horizons, strong texture contrast to greyish brown medium heavy clay subsoils and an alkaline soil reaction trend are distinguishing features of **Montrose** soil. The upper clay subsoil is strongly sodic with an exchangeable sodium percentage of 28 to 30%. The soil profile is moderately deep overlying mottled grey and brown weathered siltstone below 0.8 m depth.

The surface horizons of **Stanage** soil are thick, non-gravelly, greyish brown in colour and conspicuously bleached when dry. Surface textures are fine sandy loams and less commonly sandy loams. A layer of fine ferruginous nodules is usually present immediately above the clay subsoil. At 0.45 to 0.8 m depth there is strong texture contrast to a grey heavy clay subsoil with distinct red and yellow mottles. Soil depth ranges from 1.2 to >1.5 m. Soil reaction trend is acid or strongly acid. Laboratory analyses of selected subsoil samples show a range in cation exchange capacity from 9 to 15 me%; exchangeable magnesium and aluminium make up 80 to 90% of the cations while calcium is <10% or below the level of quantification.

Keeley soil typically has a very thick bleached sandy surface horizon overlying a grey clay subsoil. Grey to greyish brown loamy sand overlies bleached sand to 1.4m depth. Prominent red mottles are a feature of the grey medium clay subsoil. A dark brown hardpan can occur in the soil profile below 0.8 m depth. Soil reaction trend is acid.

5.2 Soils of Rises on Limestone

This unit has a restricted occurrence in the Calliope area north of Awoonga Dam. The exposed limestone is weathered and fluted in appearance and is quite distinct from other sedimentary rocks in the area. These small areas occur in undulating or rolling rises with slopes of 4 to >15%.

Cammoo is the only soil in this unit. It has a characteristic stony surface and a red structured gradational profile. The soil is well drained, generally of moderate depth (0.4 to 0.6 m) and abruptly overlies hard limestone. Dark reddish brown surface horizons of clay loam texture and strong granular structure grade to a red or reddish brown light clay with a strong grade of subangular blocky structure. The medium clay subsoil is red and also well structured. Soil reaction trend is neutral. Although free calcium carbonate was not evident in the clay subsoil, laboratory analyses from selected sampling show the dominance of calcium in the metal cations. Exchangeable calcium to magnesium ratios are 3:1 in the clay subsoil.

5.3 Soils of Hills and Rises on Granitic Rocks and Sediments

Granitic rocks and colluvial sediments of the Mirium Vale Granodiorite near Tannum Sands form gently undulating to undulating rises (slopes 2 to 8%). Associated soils are mostly bleached coarse sands. In the Yarwun - Targinie district west of Gladstone, the Targinie Granite is prominent at Mount Sugarloaf, and north of the Mount Larcom Road where it occupies a section of the eastern margin of the Mount Larcom Range. Deep red or brown coarse sands are dominant on footslopes and texture contrast soils on low gradient fans. Granite, adamellite and granodorite comprise the Bayfield Granite and an unnamed formation at Byfield. Brown or black loams occur on steep hills of the Coast Range while sandy texture contrast soils are prevalent on lower hillslopes and gently undulating rises.

Uniform or gradational soils

Gayfield is a uniform or gradational, loamy brown soil occurring on steep hillslopes in the Yarwun - Targinie and Byfield areas. Rounded stone is a characteristic soil surface feature and eucalypt forest is the associated vegetation. The soil surface horizons are dark loams or coarse sandy loams 0.12 to 0.25 m thick. These grade to a brown subsurface horizon overlying weathered granitic rock or to a weakly developed reddish brown subsoil of coarse sandy clay loam texture. Soil reaction trend is acid. Soil depth ranges from 0.45 to 1.2 m.

Raven soil is distinguished from **Gayfield** by a thick (0.4 to 0.5 m) black loamy surface. Surface stone and boulder are present on steep hillslopes, and the associated vegetation is vine forest with eucalypt emergents. Surface texture ranges from sandy loam to organic loam and a thin (0.1 m) brown subsurface horizon is usually present above the speckled coarse sandy weathered granite or granodiorite. Soil reaction trend is acid. Depth to hard rock exceeds 1.5 m. High soil surface fertility (site 616) is associated with high organic carbon content (3.7%). Cation exchange capacity is very low (<3 me%) below the organic surface horizon indicating low fertility and low nutrient retention in the deeply weathered substrate.

Meilland soil has 0.25 to 0.35 m of dark reddish brown loamy coarse sand or coarse sandy loam grading to a red or brown subsoil of sandy clay loam texture. Some profiles are coarse sandy throughout and included in this soil class. Below 1 m depth the lower subsoil or weathered parent material is usually paler, sandier and contains some gravel. Soil reaction trend is neutral or slightly acid. Laboratory analyses (sites 832 and 1018) show the low clay content (<15%) of these soils and very low cation exchange capacity (5 me%). In the soil surface horizons, available phosphorus levels are moderate to high, available sulfur and total nitrogen levels are low.

Carmine represents the heavier textured deep red gradational soils which occur in association with **Meilland**. The soil surface horizons are dark red or dark reddish brown loams or clay loams with granular to subangular blocky structure and up to 0.4 m in thickness. These grade to a red light clay subsoil which is massive or weakly structured. Texture of the lower subsoil decreases below 1 m depth. Soil reaction trend is neutral or acid. Selected subsoil samples, although of light clay texture, have very low cation exchange capacity (<5 me%).

Iveragh soil has a distinctive white coarse sandy surface at disturbed locations. At undisturbed locations the surface horizons are grey loamy coarse sands 0.1 to 0.18 m thick. These grade to a bleached white subsurface horizon of loamy coarse sand or coarse sand texture. The surface horizons overlie a cemented hardpan or granite at 0.5 to 0.9 m depth. Soil reaction trend is acid or neutral.

Texture contrast soils

Rounded granitic stone (200 to 600 mm size) is a characteristic soil surface feature of **Stoneleigh** soil. Brown or dark brown clay loamy surface horizons overlie a red medium clay subsoil at 0.15 to 0.25 m depth. The lower sandy clay subsoil is brown and speckled with weathering minerals. Soil reaction trend is neutral. Cation exchange capacity is low (16 me%) in the clay subsoil; exchangeable magnesium (55%) exceeds calcium (41%).

Swans is a brown texture contrast soil with mottles throughout the clay subsoil. The surface horizons are greyish brown to dark loamy sands or sandy loams, 0.15 to 0.25 m thick. These grade to a darker subsurface horizon usually of higher clay content. A thin paler, partly bleached, horizon can occur above the clay subsoil. Below 0.4 to 0.8 m depth, the brown sandy light or medium clay subsoils are moderately structured, mottled, and contain some fine granitic gravel. Soil reaction trend is neutral. Laboratory analyses from cropped land (site 831) show exchangeable calcium as the dominant cation throughout the profile and the clay subsoil to have a low to moderate cation exchange capacity (18 to 22 me%). Total phosphorus and potassium levels are high throughout the profile.

Flanders soil has 0.2 to 0.3 m of dark to dark greyish brown sandy loam over 0.45 to 0.55 m of pale yellow sandy loam or occasionally coarse sandy clay loam. There is strong texture contrast to a grey medium clay subsoil with either red or yellow mottles. Soils with thin yellow brown upper clay subsoils grading to grey lower subsoils are related to this soil class. Soil reaction trend is acid or strongly acid. The clay subsoil has very low cation exchange capacity (6 to 10 me%) and is dominated by either exchangeable magnesium or aluminium. The landform is gently sloping and the soil profile is not seasonally saturated.

Broughton soil has 0.12 to 0.3 m of dark greyish brown loamy coarse sand or loamy sand over 0.58 to 0.65 m of pale yellow coarse sandy loam increasing to coarse sandy clay loam. There is a clear texture change to a grey coarse sandy medium heavy clay subsoil with prominent red mottles. Soil reaction trend is acid or strongly acid. Cation exchange capacity is very low (6 me%) in the upper clay subsoil and exchangeable magnesium is dominant (site 593). The level of available phosphorus is very low (1 mg/kg) in the soil surface horizon; total phosphorus is very low (0.005%) throughout the profile. The landform is gently sloping and the soil profile is not seasonally saturated.

Yaxley has 0.15 to 0.3 m of greyish brown or dark greyish brown sandy loam over 0.5 to 0.7 m of bleached sandy loam. A thin (< 0.2 m) yellowish brown sandy clay loam subsurface horizon can be present above the clay subsoil. The grey medium heavy clay subsoil has distinct red or yellow mottles. Soil reaction trend is acid. The clay subsoil has very low cation exchange capacity (6 me%) and is dominated by either exchangeable magnesium or aluminium. The landform is essentially flat and the soil profile is seasonally saturated.

Arnolds soil has 0.15 to 0.2 m of grey or dark greyish brown loamy sandy or loamy coarse sand over 0.45 to 0.7 m of bleached loamy sand. The texture change is abrupt to a grey medium heavy clay subsoil with red or orange mottles. Soil reaction trend is acid. Cation exchange capacity is very low in the upper clay subsoil (5 to 8 me%) and exchangeable magnesium is dominant. The landform is essentially flat and the soil profile is seasonally saturated.

An alkaline soil reaction trend, hardsetting soil surface and conspicuously bleached subsurface horizon are features common to **Voewood** soil. The surface horizons are greyish brown to dark greyish brown sandy loams or fine sandy loams 0.05 to 0.2 m thick. The bleached subsurface horizon of similar texture ranges in thickness from 0.1 to 0.2 m. There is an abrupt textural change to a grey or yellowish brown medium clay subsoil with distinct mottles. The lower clay subsoil below 1 m depth is dominantly grey with yellow mottles and often contains manganese segregations. Exchangeable sodium percentage in the upper clay subsoil ranges from 14 to 22%. Cation exchange capacity ranges from 8 to 21 me% and magnesium is the dominant cation (52 to 65%).

Newen soil has a massive bleached surface of sandy loam to coarse sandy loam texture. There is an abrupt change at 0.3 to 0.4 m depth to a thin (0.1 m) mottled brown clay subsoil. This overlies a grey or greyish brown cemented hardpan of clayey coarse sand texture. Soil reaction trend is alkaline. The thin brown clay subsoil is strongly sodic (24% exchangeable sodium).

5.4 Soils of Hills and Rises on Volcanic Rocks

Most soils of this group occur in the Calliope area. They are associated with a range of fine grained (andesite) to coarse grained (agglomerate) volcanic rocks. Much of the area is represented by the Calliope and Berseker Beds (Holmes and Donchak 1988). Common rock types include andesite, rhyolite, greenstone, and sedimentary rocks containing volcanic material. The landform consists of gently undulating rises to steep low hills. A small area with acid to intermediate welded tuff and agglomerate occurs north of Yeppoon (Willmott *et al.* 1986). Steep rises and steep low hills are common in this area.

Gradational soils

The gravelly brown or red gradational soil **Beaks** has a distinctive black surface in the Yeppoon area. Elsewhere the surface horizons are greyish brown loams or sandy loams up to 0.2 m thick. These are underlain by a paler brown subsurface horizon of similar texture and high gravel content. There is a gradual change to a brown or red subsoil of sandy clay loam or sandy light clay texture. The soil profile is moderately deep (0.5 to 1.2 m) and occasionally has surface stone and rock outcrop. Soil reaction trend is acid or strongly acid. Laboratory data for site 1133 (north of Yeppoon), shows the high organic carbon content of the soil surface (4.4%), the gradual clay increase with depth, and the dominance of magnesium and aluminium in the subsoil cations.

Muldoon soil has variable soil depth ranging from 0.25 m on ridge crests to 1.2 m on lower slope positions. Soil depth is generally <0.5 m. The intermittent occurrence of surface stone and rock outcrop are associated features. Structured brown to reddish brown clay loamy or clayey surface horizons grade to structured red or brown clay subsoils. Soil reaction trend is neutral. Laboratory analyses (site 822) show a medium level of organic carbon and high levels of total nitrogen and available phosphorus in the soil surface horizon. The ratio of exchangeable calcium to magnesium throughout the profile is 4 to 1.

Texture contrast soils

Stevens is a red texture contrast soil with a well structured black clay loamy surface horizon. The soil surface horizon ranges in thickness from 0.22 to 0.35 m, and is gravelly. This grades to a paler subsurface horizon of similar texture and gravel content. The soil surface horizons overlie a structured red clay subsoil at 0.3 to 0.45 m depth. The red clay subsoil continues to depths >1.5 m on lower hillslope positions. The lower clay subsoil of profiles on mid slope positions are usually reddish brown grading to yellowish red and mottled. Soil reaction trend is acid or strongly acid. Laboratory analyses of the **Stevens** profile (site 1132) show a clay content of 32% in the soil surface horizon increasing to 69% in the clay subsoil. Cation exchange capacity in the clay subsoil is very low (7 me%) with exchangeable aluminium as the dominant cation. The soil surface horizon has high total nitrogen (0.29%) and very high organic carbon (5.9%).

A gravelly dark clay loamy surface horizon and contrasting brown or yellowish brown clayey subsoil are characteristics of **Boyles** soil. Commonly, a pale subsurface horizon is present and partly bleached. At 0.25 to 0.34 m depth the clay subsoil is of medium heavy texture with a few mottles. Below 1 m depth the lower clay subsoil is a mottled heavy clay and frequently contains manganese segregations or concretions. Soil reaction trend is alkaline. The upper clay subsoil is non-sodic. Cation exchange capacity is moderate (>20me%) and exchangeable calcium and magnesium occur in approximately equal proportions.

Yarwun soil, a similar yellowish brown alkaline texture contrast soil, is distinguished from **Boyles** by a conspicuously bleached subsurface horizon and sodic upper clay subsoil. Cation exchange capacity of the upper clay subsoil at 0.2 to 0.32 m depth ranges from 23 to 28 me%. Exchangeable magnesium is the dominant cation. Exchangeable sodium percentage ranges from 7 to 21%.

Uniform clays

Shingle soil occurs over a small basalt rise in the Targinie area. It is represented by a single soil description from an exposure. The soil surface horizons are very cobbly (50 to 90% cobble), black in colour, and of light clay texture with strong granular structure grading to strong subangular blocky structure. The medium clay subsoil is red, gravelly and moderately structured. Soil reaction trend is alkaline.

Bompa soil represents the darker heavier textured (higher clay content) soils formed on intermediate to basic volcanic rocks. Variations within the **Muldoon** soil class are closely associated. The depth of **Bompa** soil to weathered rock is variable and shallow ranging from 0.4 m on ridge crests to 0.8 m on lower slope positions. The surface horizons are dark light clays with moderate structure and occasionally rock outcrop. There is a gradual change with depth to a brown or black medium to heavy clay subsoil. The lower clay subsoil is commonly light olive brown with soft weathered rock fragments. Soil reaction trend is neutral. Laboratory analyses (site 133) show a moderate cation exchange capacity (25 me%) in the clay subsoil, and exchangeable calcium to be the dominant cation. The soil surface contains low levels of available phosphorus and total nitrogen.

5.5 Soils of Drainage Lines, Creek Terraces and Plains

A wide range of soils from sands to heavy clays have formed in local alluvium associated with drainage lines, creek terraces and plains. Deep sands and loams are dominant on local alluvium from granitic rocks, texture contrast soils with sodic subsoils from sedimentary rocks and metasediments, and deep heavy cracking clays from adjacent volcanic rocks. Much of the alluvial land has restricted drainage and is seasonally wet, low lying and frost affected.

Uniform sands

Military is a yellowish brown sandy alluvial soil with few soil horizons. The surface horizons are greyish brown to dark greyish brown loamy sands 0.26 to 0.4 m thick. These grade to a whole coloured yellowish brown sand or loamy sand and continue to below 1.5 m depth. Soil reaction trend is acid. Cation exchange capacity at 0.4 m depth is very low (1 me%). The levels of exchangeable calcium, magnesium and potassium are below the levels of sufficiency for agricultural crops.

Austins is a uniform sandy textured soil with a well developed profile. The surface horizons are grey to dark grey loamy sands. These grade to a bleached white sand. Below 0.6 to 0.9 m depth the subsoil is brown, whole-coloured and has earthy fabric. There is a gradual change below 1m depth to a pale brown or yellowish sand. Soil reaction trend is acid. Cation exchange capacity at 0.6 m depth is very low (2 me%). The levels of exchangeable calcium, magnesium and potassium are below the levels of sufficiency for agricultural crops.

Uniform loams and clay loams

Valetta soil has a uniform loamy texture profile, with a massive whole-coloured brown or reddish brown subsoil with earthy fabric. Surface horizon colour ranges from dark greyish brown to black. Buried soil or gravel layers can occur below 0.5 m depth. Soil reaction trend is neutral or acid. Laboratory analyses (site 615) show a uniform low clay content (15%) throughout the profile. Cation exchange capacity at this site is very low (<3 me%) and the levels of exchangeable calcium, magnesium and potassium are below the levels of sufficiency for agricultural crops. Higher cation exchange capacities to 8 me% were measured elsewhere on selected subsoil samples for this soil class.

Magnan soil has developed in the water gathering sites of narrow drainage lines, plains and lower slopes. The surface horizons are greyish brown silty loams or clay loams 0.09 to 0.25 m thick. These grade to a bleached clay loamy subsurface which contains manganese nodules. The bleached subsurface directly overlies a grey cemented manganiferous hardpan with gravel. Soil depth to the hardpan ranges from 0.2 to 0.65 m. Soil reaction trend is acid. The type of material underlying the pan is unknown. The hardpan is locally called conglomerate.

Lidon soil is essentially shallow with soil surface horizons (to 0.3 m thick) overlying buried layers of granitic alluvium and clay sediment. Dark greyish brown clay loam surface horizons with weak cast

structure overlie massive bleached clay loam subsurface horizons. Between 0.25 m and 1 m depth, buried layers of mottled grey and yellowish brown granitic alluvium of coarse sandy light clay to sandy medium heavy clay occur. These are partly saturated. Gleyed heavy clay is present below 1 m depth. Soil reaction trend is neutral.

Gradational soils

Ruby is a gravelly red or reddish brown gradational soil associated with deep erosion gullies, drainage lines and low gradient fans. The surface horizons are brown or dark reddish brown gravelly clay loams 0.15 to 0.4 m thick. Surface structure is moderate granular or cast. There is a gradual change to a red or brown massive subsoil of gravelly light clay texture. The soil profile is deep (> 2 m) and buried layers can occur below 0.6 m. Soil reaction trend is acid or neutral. Laboratory analyses (site 250) display very low cation exchange capacity (<6 me%) throughout the profile, low levels of exchangeable potassium below the soil surface, but sufficient levels of exchangeable calcium and magnesium for most agricultural crops. Low levels of total nitrogen, available phosphorus and sulfur are present in the soil surface.

Corduroy is a black structured gradational soil. The surface horizons are black or dark brown clay loams which grade with depth to black or dark strongly structured light clays. At 0.7 to 1 m depth the dark clay subsoil grades to mottled grey medium clay which contains some manganese nodules, or to brown clay with layers of water-worn gravels. The soil profile is deep (> 1.5 m) and soil reaction trend is neutral or alkaline. The soil profile (site 289) has low to medium electrical conductivity (<0.5 dS/m) and chloride ion concentration (<500 mg/kg) below 1.2 m depth. Cation exchange capacity is moderate in the soil surface horizon and upper clay subsoil. The soil surface has high organic carbon and available sulfur, an adequate level of micronutrients and a low level of available phosphorus.

Paddys soil is characterised by a thick bleached dilatant surface overlying a grey cemented hardpan. Changes with depth are gradual and the soil is acid throughout. The surface horizons are pale greyish brown fine sandy loams, massive, hardsetting and bleached when dry. At 0.5 m depth the texture changes gradually to fine sandy clay loam and continues to1.1 m depth. This soil layer is grey to greyish brown in colour, massive, and cemented when dry.

Texture contrast soils

Dale is a brown texture contrast soil underlain by buried soil layers. Surface horizons are dark greyish brown to black coarse sandy clay loams to clay loams 0.25 to 0.35 m thick. The medium clay subsoil is brown, usually with some grey mottles, and weakly structured. There is a marked decrease in texture to the underlying buried soil layers. Alternating layers of loamy coarse sand and clay occur below 0.45 m depth. Soil reaction trend is neutral.

At the junction of narrow drainage depressions and terraced alluvium of the Boyne River occurs the dark texture contrast soil with normal gilgai microrelief, **Kindara**. A dark loamy surface horizon overlies a paler subsurface horizon (partly bleached) with some yellow mottles. The shallow (0.15 m) medium clay subsoil is black, moderately structured and contains some manganese nodules. The lower heavy clay subsoil is yellowish brown, has moderate lenticular structure and manganese nodules. Soil reaction trend is alkaline.

Adsett has formed in fine sandy alluvium derived from both sedimentary and granitic rocks. The soil class is poorly drained, and where surface drainage is restricted, normal gilgai microrelief occurs. The surface horizons are dark grey or greyish brown loamy sands or loamy fine sands 0.15 to 0.3 m thick. These grade to a bleached subsurface of similar texture which usually contains some manganese nodules. At 0.4 to 0.5 m depth there is an abrupt change to a mottled weakly structured clay subsoil. The moderately structured lower subsoil overlies a cemented hardpan or continues to

below 1.5 m depth. Soil reaction trend is acid. Selected chemical data for the clay subsoil shows very low cation exchange capacity (5 me%) and magnesium as the dominant cation.

Yeppoon soil occurs over extensive areas near Yeppoon. It is a deep (> 1.5 m) grey to pale brown texture contrast or gradational soil with a characteristic silty surface. The surface horizons are greyish brown silty loams or silty clay loams 0.09 to 0.3 m thick often with cast structure from worm activity. The bleached subsurface of similar texture ranges from 0.1 to 0.3 m in thickness. There is a clear or gradual change to a grey or pale brown clay subsoil with yellow mottles. The lower clay subsoil may contain some gravel. Manganese nodules occur throughout the profile. Soil reaction trend is acid or neutral. Exchangeable sodium in the upper clay subsoil ranges from 6 to 12 %.

Yaringa soil is deep (> 1.5 m), has an alkaline soil reaction trend and normal gilgai microrelief where drainage is severely restricted. The surface horizons are greyish brown or dark greyish brown silty loams or silty clay loams 0.05 to 0.15 m thick. The bleached subsurface of similar texture ranges from 0.05 to 0.2 m in thickness. Mottling is distinct in the upper medium clay subsoil, and the lower subsoil features include lenticular structure, carbonate concretions and manganese nodules. Laboratory analyses (site 128) show 26% clay in the surface horizons and 67% clay at the top of the clay subsoil. Cation exchange capacity increases from 7 me% in the soil surface horizons to 26 me% at the top of the clay subsoil and to 38 me% in the lower clay subsoil. Exchangeable sodium increases from 9% in the upper clay subsoil to 16% in the lower subsoil. A low level of total nitrogen and a very low level of available phosphorus were measured in the soil surface.

Lorna is an alkaline texture contrast soil and distinguished from **Yaringa** by clay loamy or loamy surface horizons. These are greyish brown or dark greyish brown clay loams or fine sandy loams, 0.9 to 0.2 m thick with moderate cast structure. The massive bleached subsurface horizon ranges from 0.1 to 0.18 m in thickness. Mottling occurs in the yellowish brown medium clay upper subsoil. The medium heavy clay lower subsoil is grey in colour with distinct brown mottles. Some manganese nodules and gravel can occur throughout the profile. Soil reaction trend is neutral or alkaline. Exchangeable sodium in the upper clay subsoil ranges from 6 to 15%.

Teralba is an acid grey to brown texture contrast soil with a thick 0.5 to 0.7 m loamy surface. Bleached layers occasionally with yellow mottles occur below 0.2 m depth. There is an abrupt change to a grey to brown structured medium clay subsoil with yellowish brown or red mottles. Soil depth generally exceeds 1.5 m. Soil reaction trend is acid. A shallow perched watertable or cemented grey hardpan can occur in the profile below 0.5 m depth. Selected sampling indicates the upper clay subsoil to be sodic (12%) with very low exchangeable calcium.

Simpsons soil represents high level alluvium of Sandy and Water Park Creeks. It is texture contrast with a very thick surface and a weakly structured brown clay subsoil. The surface horizons are greyish brown loamy fine sands, 0.1 to 0.15 m thick. There is a gradual change to a very thick (1 m) pale yellow subsurface horizon of loamy fine sand texture. The change is then clear to a brown fine sandy clay subsoil with some yellow mottles. Texture decreases in the yellowish red lower subsoil to sandy clay loam. Soil reaction trend is acid. Laboratory analyses (site 588) show a low level of total nitrogen and very low levels of available phosphorus and sulfur in the soil surface. Cation exchange capacity is very low throughout the profile and the levels of exchangeable calcium, magnesium and potassium are below the level of sufficiency for most agricultural crops.

Uniform clays

Plain soil occupies the main drainage floor between the Coast Range and Adelaide Park Road, Yeppoon. It has a uniform clay texture profile and gravel at moderate depth (0.5 m). The surface horizons are black, moderate to strongly structured light clays, 0.1 to 0.25 m thick. The medium clay subsoil is also black in colour and strongly structured. This overlies mottled grey or dark grey clay with abundant rounded gravels. Soil reaction trend is neutral.

Deep black non-cracking clay soils with normal gilgai microrelief, **Cottons**, are found in the alluvium of Limestone Creek. They have 0.15 m of moderately structured dark medium clay overlying black medium heavy clay grading to heavy clay. Below 0.5 m depth the heavy clay subsoil has lenticular structure and contains some carbonate and manganese nodules. Soil reaction trend is alkaline. The upper clay subsoil is non-sodic (1 to 3% exchangeable sodium) and magnesium dominant (58 to 69% exchangeable magnesium).

Ironport is a deep grey non-cracking clay with normal gilgai microrelief. The soil has features indicating pronounced seasonal wetness. These include the development of a partly bleached subsurface horizon, orange mottling in the surface horizons and manganese nodules. The light medium clay surface horizons are moderately structured and overlie medium heavy clays grading to heavy clays at shallow depth (0.2 to 0.3 m). The heavy clay subsoils exhibit moderate lenticular structure and contain some manganese nodules and carbonate concretions. Soil reaction trend is alkaline.

Cassandra represents the deep brown or black cracking clay soils with normal gilgai microrelief. They have 0.1 to 0.2 m of moderately structured dark medium clay overlying dark grey, brown or black heavy clay. At 1 m depth the heavy clay subsoil exhibits strong lenticular structure and contains some carbonate and manganese nodules. Soil reaction trend is alkaline. Laboratory analyses (site 134) show that electrical conductivity and chloride ion concentrations are much higher than those of other profiles. Cation exchange capacity is moderate throughout the profile (29 to 48 me%). The clay subsoil is sodic (10%) at 0.5 m depth increasing to 20% below 1 m. The soil surface horizon has high organic carbon, but very low available phosphorus.

Deep grey cracking clays with normal gilgai microrelief, **Ashen**, are usually situated in less well drained locations. The soils have dark greyish brown medium clay surface horizons 0.1 to 0.15 m thick. Grey to dark grey heavy clay subsoils often contain rusty flecking and manganese segregations. The lower heavy clay subsoil is often olive grey with carbonate concretions. Soil reaction trend is alkaline.

5.6 Soils of River Terraces

This soil group comprises alluvium of the Boyne and Calliope Rivers. Low and high terrace levels are present in the lower section of both river systems. Terrace levels are more pronounced along the Boyne River. Soil profile development on the river terraces is related to differences in age, parent material and drainage. Soils situated on the low terrace (uniform sands, loams and gradational soils) generally have moderate fertility.

Uniform sands and loams

Arnica, a brown sandy alluvial soil, occurs on the low terrace and is separated from the present stream channel by a gravel bench. The soil has little profile development beyond 0.22 m depth and overlies layers of sand, loamy fine sand and gravel to > 1.5 m depth. Soil reaction of the layered alluvium ranges from neutral to acid. **Arnica** is recognised as the youngest soil of the terrace sequence. The soil surface has very low cation exchange capacity (6 me%) with exchangeable calcium as the dominant cation.

Berrigan is distinguished from similar sandy soils by an abundance of water-worn gravels at moderate depth (0.4 to 0.6 m). The surface horizons are dark or black sandy loams or loamy sands. The brown sandy subsoil is massive with earthy fabric. Soil reaction trend is neutral.

Boyanda is characterised by a deep uniform sandy texture profile, massive whole-coloured brown subsoil with earthy or sandy fabric. The surface horizons are black and thick (0.3 to 0.45 m). Soil

reaction trend is neutral or acid. Laboratory analyses (site 210) show the upper surface sample to have low cation exchange capacity (10 me%), decreasing to a very low level (6 me%) in the lower surface and subsoil samples. The level of total potassium is high and total phosphorus high, decreasing to moderate throughout the profile. The soil surface has a moderate level of organic carbon and available phosphorus, and a very low level of available sulfur.

Gradational soils

Benaraby has a gradational texture profile, massive whole-coloured brown subsoil with earthy fabric. The surface horizons are loamy, black and thick (0.4 m). At 1.2 m depth the lower subsoil is reddish brown in colour and continues to below 1.6 m. Soil reaction trend is neutral. Laboratory analyses (site 415) show a high level of total phosphorus and potassium throughout the profile. Exchangeable calcium is the dominant cation. Cation exchange capacity is very low (5 to 7 me%). In the soil surface horizon, available phosphorus is high while the levels of organic carbon and total nitrogen are low, and available sulfur is very low.

Ceduna is a gradational textured soil with a structured brown clay subsoil. The surface horizons are black or dark fine sandy loams 0.35 to 0.48 m thick. There is a gradual change to a brown or strong brown light clay or light medium clay subsoil which is moderately or strongly structured. The lower clay subsoil colour varies from dark grey and brown to yellowish brown, and can be sodic (exchangeable sodium 16%) below 1.2 m depth. The level of available phosphorus is high in the soil surface (62 mg/kg). Soil reaction trend is neutral.

Catalina occurs mostly on undulating terraces which have been incised by stream channels and back-filled with fine sediments. Narrow levees (< 30 m wide) with **Boyanda** soil form part of the undulating terrace surface. The soil surface is black, clay loamy in texture and strongly structured. There is a gradual change to a brown light clay subsoil which is moderately or strongly structured. Buried soil layers can occur below 0.7 m depth. Soil reaction trend is neutral. Cation exchange capacity is low (18 me%) and exchangeable calcium is dominant (67%) in the upper clay subsoil.

Texture contrast soils

Diglum has 0.2 m of black clay loam overlying 0.15 to 0.2 m of partly bleached dark greyish brown clay loam. There is a clear textural change to a black medium clay subsoil which is moderately structured. The lower clay subsoil is also black, strongly structured and contains some carbonate concretions. Soil reaction trend is alkaline. Cation exchange capacity in the clay subsoil is moderate (28 to 30 me%), site 414. Exchangeable calcium > magnesium > sodium, throughout the soil profile. The upper clay subsoil can be sodic (7%) and the lower clay subsoil strongly sodic (17%). The level of total phosphorus is very high in the soil surface decreasing to a moderate level below 0.9 m depth. Total potassium is high throughout the profile. Organic carbon and available phosphorus levels are high in the soil surface.

Kenway soil is associated with depressional areas within the alluvium. The surface horizons are dark fine sandy loams grading to sandy clay loams with yellow mottles and manganese resulting from seasonal wetness. The light clay subsoil overlies buried soil layers below 0.5 m depth.

The surface horizons of **Harwood** soil are hardsetting dark greyish brown fine sandy loams or fine sandy clay loams 0.1 to 0.35 m thick. The bleached subsurface horizon ranges in thickness from 0.05 to 0.15 m. There is an abrupt change to a yellowish brown or brown light medium or medium clay subsoil with grey mottles. Soil reaction trend is alkaline. At some locations field electrical conductivity readings are high (>1 dS/m) at 1m depth, and selected upper clay subsoil samples have an exchangeable sodium percentage ranging from 6 to 15%. The clay subsoil at site 1109 is sodic (7%) at 0.5 m depth increasing to 11% below 1 m.

Camona has a black fine sandy loam or sandy clay loam surface horizon. The paler subsurface horizon is partly bleached and abruptly overlies a yellowish brown light medium clay subsoil. Soil reaction trend is alkaline. Exchangeable sodium percentage in the upper clay subsoil is moderate ranging from 11 to 15%.

Dorall soil is more strongly sodic in the upper clay subsoil (25%), has a mottled heavier clay subsoil and a characteristic dark silty surface. Manganese nodules occur in the partly bleached subsurface horizon and throughout the deep clay subsoil. Soil reaction trend is alkaline.

Pitt represents the oldest, and usually the most elevated alluvium of the Boyne River. The surface horizons are silty or fine sandy, greyish brown in colour, and have hummocky microrelief where surface drainage is restricted. The bleached subsurface horizon of similar texture abruptly overlies a grey medium heavy clay subsoil with yellow or brown mottles. Soil reaction trend is alkaline. The clay subsoil (site 358) is strongly sodic (32%) at shallow depth (0.5 m) and has high electrical conductivity and chloride ion values. The level of total potassium is high throughout the profile. The levels of available phosphorus and sulfur are moderate while the levels of organic carbon and total nitrogen are low in the soil surface.

Sandralee soil has 0.15 to 0.3 m of greyish brown loamy sand over 0.15 to 0.4 m of bleached loamy sand. The texture change is abrupt to a greyish brown medium clay subsoil, with yellow mottles. Soil reaction trend is alkaline. The upper clay subsoil is sodic (14%) and exchangeable magnesium is the dominant cation (50%).

Stowe is an association of brown texture contrast soils and brown cracking clays with normal gilgai microrelief. This soil association (gilgaied clays set in a planar surface) occurs on slightly more elevated land in relation to **Larcom** soil, on the high terrace of the Calliope River. The texture contrast soils typically have a thin (<0.2 m) clay loamy surface horizon and are bleached. The brown medium or medium heavy clay subsoil grades with depth to olive brown or dark brown heavy clay. Lenticular structure and carbonate concretions are features of the lower clay subsoil. Soil reaction trend is alkaline. Exchangeable sodium in the upper clay subsoil ranges from 7 to 9% and exchangeable magnesium is the dominant cation (50 to 61%). The associated brown cracking clay soils have medium clay texture at the soil surface grading to heavy clays at shallow depth. Brown clay subsoils grade to light olive brown or grey lower subsoils with lenticular structure and carbonate concretions. Soil reaction trend is alkaline.

Uniform clays

Brooks soil occurs on the low terrace of the Calliope River at Oaky Creek junction. It has a uniform clay texture profile overlying buried soil layers. The soil surface horizons are dark greyish brown to black light to medium clays with strong cast structure. The medium clay subsoil is dark in colour and moderately structured. Buried layers of dark grey sandy clay and light clay occur below 0.7 m depth. Soil reaction trend is neutral. Cation exchange capacity in the soil surface (0.2 m depth sample) is low to moderate (19 me%), with exchangeable calcium as the dominant cation (58%).

Larcom soil is a brown or grey heavy cracking clay with normal gilgai microrelief. Dark greyish brown moderately structured surface horizons 0.1 to 0.15 m thick overlie weakly structured brown or grey heavy clay subsoils with manganese nodules and segregations. The darker lower subsoil below 1 m depth is well structured and contains carbonate concretions and manganese nodules. Soil reaction trend is alkaline. Laboratory analyses (site 1112), show a clay content of 65% in the surface horizon increasing to 69% in the upper subsoil. Cation exchange capacity is moderate throughout the profile (30 to 40 me%) with exchangeable magnesium as the dominant cation. Exchangeable sodium comprises 9% of the cations in the upper clay subsoil and 19% in the lower clay subsoil. The soil surface has a moderate level of organic carbon and a low level of total nitrogen, available phosphorus and sulfur.

Evander is a deep (>1.5 m) grey to brown non-cracking clay with normal gilgai microrelief. The light clay surface horizons are partly bleached and overlie medium clays grading to heavy clays at shallow depth (0.15 to 0.2 m). Soil reaction trend is neutral or alkaline. Laboratory analyses (site 413) show a moderate cation exchange capacity throughout the clay subsoil (20 to 34%), with exchangeable magnesium as the dominant cation. The upper clay subsoil is sodic (8%) and the lower subsoil strongly sodic (21%). The levels of total potassium are high throughout the profile. The soil surface has a high level of organic carbon and a moderate level of total nitrogen, available phosphorus and sulfur.

Marla is a deep dark cracking clay with normal gilgai microrelief. The medium clay surface horizon is moderately structured, and has orange mottles. The dark heavy clay subsoil grades with depth to a dark grey heavy clay with lenticular structure. Soil reaction trend is alkaline.

Narva occupies a back swamp adjacent to Awoonga Dam Road. The dark grey medium clay surface is mottled and has well developed hummocky microrelief. The dark grey heavy clay subsoil is also mottled but weakly structured. Below 1 m depth the pale grey heavy clay is strongly structured. Soil reaction trend is alkaline.

5.7 Soils of Beach Ridges and Sand Plains

Low beach ridges (sand ridges) and swales (sandy depressions), in the survey area, occur along the coastline at Tannum Sands and Kinka. They are aligned approximately parallel to the present coastline and their associated soils show evidence of at least two distinct periods of landform development. Remnants of a dissected sand plain occur along the eastern boundary of the survey area north of Yeppoon.

Selina represents the linear association of narrow sand ridges and narrow sandy swales with an alkaline substrate. The soil profile of the ridges is weakly developed (has few horizons) in comparison with the well developed swale profile. On ridges, the surface horizons are brown or dark greyish brown fine sands. There is a gradual change at 0.1 to 0.15 m depth to brown or yellowish brown fine sand. Between 0.4 and 3 m depth the light yellowish brown fine sand is alkaline and contains shell fragments. The soil surface horizon within swales is a dark grey or greyish brown fine sand up to 0.4 m thick. This grades to a bleached fine sand subsurface horizon. Below 0.8 m depth, the yellowish brown and light yellowish brown fine sand is alkaline with shell fragments. Laboratory analyses sites 434 and 435 show the dominance of fine sand (82 to 92%) throughout the profiles. Total phosphorus and potassium levels are generally moderate. In the soil surface, available phosphorus levels are moderate or high while the levels while available sulfur, organic carbon and total nitrogen are low.

Kinka represents the linear association of narrow sand ridges and broader sandy depressions (swales), with a neutral or acid substrate. Soil horizon colours are generally paler or yellower than those of **Selina**. The fine sand substrate is different having a neutral or acid soil reaction and no shell fragments. Laboratory analyses of samples from a ridge site (205), show low levels of total phosphorus and potassium throughout the profile. The soil surface has a low level organic carbon and total nitrogen, and a very low level of available phosphorus and sulfur.

Kellys soil has a very thick (>1 m) bleached sandy surface overlying brown sand. It occurs on remnants of a dissected sand plain adjacent to Kellys Landing Road, Yeppoon. The surface horizons are light grey in colour, sand or loamy sand in texture and 0.1 to 0.15 m in thickness. These grade to a bleached white subsurface horizon of sand texture. The surface horizons overlie brown sand at 1.1 to 1.3 m depth. Soil reaction trend is acid.

Mulambin soil represents the wet beach ridge plain margin and incised drainage areas at Kinka. The surface horizons are dark grey sands or black sandy loams 0.3 m thick. These grade to a bleached sand subsurface horizon 0.4 to 0.7 m in thickness. The subsoil is brown in colour, sand in texture, and either single grain or massive. A cemented hardpan or watertable can occur at 1.3 to 1.5 m depth.

5.8 Soils of Tidal Flats

An extensive area of tidal flats occur west of Causeway Lake and adjacent to South Trees Inlet. Areas with mangrove vegetation and stream channels are tidal. The highest parts of these flats are usually only covered by very high tides. The flats contain salt pans and consist dominantly of clayey material which usually sets hard when dry and in places exhibits polygonal cracking.

Areas with **Tilden** soil are supratidal (infrequently inundated by tidal waters) and essentially devoid of vegetation, except for some patches of marine couch and samphire. The brown silty light clay surface horizon is 0.05 to 0.1 m thick with platy structure. Below this depth the soil profile is essentially layered grey to greenish grey light to medium clays. Yellow mottling occurs in the grey clay immediately above the watertable. The soil profile is saline with electrical conductivity values ranging from 7 to 60 dS/m, and contains sulfidic materials with a total potential acidity of >1000 moles of hydrogen per tonne of soil at 0.3 to 0.6 m depth (sites 451 and 567).

Hoogly is elevated (extratidal) in relation to **Tilden**. The surface horizons are dark or black light or medium clays 0.15 to 0.18 m thick. The grey medium clay subsoil is moderately structured and has distinct brown or orange mottles. Below 0.4 to 0.8 m depth the light grey, greenish grey, heavy clay lower subsoil has prominent mottles and some gravel. The upper clay subsoil is strongly sodic (55% exchangeable sodium) at shallow depth (0.2 m).

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APPENDIX I

Land Suitability Framework for Central Queensland Coast Horticultural Lands

CLIMATE (c)

Attribute	Suitability subclass						
	Plantation, Tree and Vine Crops					Vegetable Crops	Sown Pastures
Average Annual Rainfall	Pineapple, Papaw, Lychee, Passionfruit.	Citrus, Persimmon, Custard apple, Macadamia.	Mango, Stonefruit, Avocado.	Fig.	Grape.	Cucurbits, Capsicum, Tomato.	Green panic, Rhodes, Stylo, Silk sorghum, Annual sorghum, Setaria.
< 1000 mm (Calliope Area)	c1	c1	c1	c2	c2	c1	c2
1000 - 1400 mm (Yeppoon Area)	c1	c1	c2	c2	c5	c2	c2
> 1400 mm (Byfield Area)	c2	c3	c4	c5	c5	c3	c2

Notes: For crop production, higher rainfall and associated humidity increases the difficulty in controlling fungal diseases and insect populations. Fruit splitting occurs with crops requiring a dry season finish (Macleod and Paterson 1991). Sown pasture production is affected by low spring rainfall in all areas.

FROST (cf)

Attribute	Suitability subclass				
	Plantation, Tree and Vine Crops			Vegetable Crops	Sown Pastures
Frost Occurrence	**Fig, Persimmon, Citrus, Grape, Stonefruit.**	**Lychee, Macadamia, Mango, Carambola.**	**Custard apple, Avocado, Papaw, Pineapple, Passionfruit.**	**Cucurbits, Capsicum, Tomato.**	**Green panic, Rhodes, Stylo, Silk sorghum, Annual sorghum, Setaria.**
frost free	cf1	cf1	cf1	cf1	cf1
light frost winter only	cf1	cf2	cf2	cf3	cf1
light frost autumn to spring	cf1	cf3	cf3	cf4	cf1
heavy frost winter only	cf1	cf4	cf5	cf5	cf2
heavy frost autumn to spring	cf1	cf5	cf5	cf5	cf3

Notes:

Chilling requirement of stonefruit and grape assumed to be adequate on frost free land.

Examples of low lying frost free land are Farnborough and the Boyne River terraces adjacent to Awoonga Dam.

A screen temperature of 2^{o}C will generally correspond to a light frost and 0^{o}C to a heavy frost.

Attribute level based on local landholder experience.

WATER AVAILABILITY (m)

Attribute	Suitability subclass					
	Plantation, Tree and Vine Crops			Vegetable Crops	Sown Pastures	
Estimated plant available water capacity (PAWC)	Pineapple	Grape, Passionfruit.	Fig, Persimmon, Citrus, Stonefruit, Custard apple, Avocado, Papaw, Lychee, Macadamia, Mango, Carambola.	Cucurbits, Capsicum, Tomato.	Green panic, Rhodes, Stylo, Setaria.	Silk sorghum, Annual sorghum.
> 150 mm	m1	m1	m1	m1	m1	m1
125 - 150 mm	m1	m1	m2	m1	m1	m2
100 - 125 mm	m1	m2	m2	m1	m1	m3
75 - 100 mm	m1	m2	m3	m1	m2	m3
60 - 75 mm	m1	m3	m4	m2	m3	m4
40 - 60 mm	m3	m3	m5	m3	m3	m5
< 40 mm	m4	m4	m5	m4	m4	m5

Notes:

Sown pastures and pineapple are assessed under dryland conditions. Other crops using a trickle irrigation system.

Estimated PAWC to 1.2m for tree crops, 1m for grape, passionfruit, and sorghum, 0.5m for vegetable crops and remaining pastures.

Effective rooting depth determined by:

depth to hard pan or hard rock

- salinity (EC > 1 dS/m)
- sodicity (Exch.Na > 6% and ECEC > 5 m.e. %)
- aluminium (Exch.Al > 50% of ECEC and ECEC > 5 m.e. % with pH < 5.5)
- magnesium dominant clays (Ca:Mg ratio of < 0.5 and ECEC > 5 m.e. %)

NUTRIENT DEFICIENCY (nd)

Attribute	Suitability subclass		
	Plantation, Tree and Vine Crops	Vegetable Crops	Sown Pastures
Nutrient levels	Fig, Persimmon, Citrus, Grape, Stonefruit, Custard apple, Avocado, Papaw, Pineapple, Lychee, Macadamia, Mango, Carambola, Passionfruit.	Cucurbits, Capsicum, Tomato.	Green panic, Rhodes, Stylo, Silk sorghum, Annual sorghum, Setaria.
adequate or unknown	nd1	nd1	nd1
low bicarbonate phosphorus or total nitrogen only	nd1	nd1	nd2
low bicarbonate phosphorus and total nitrogen only	nd1	nd1	nd3
very low bicarbonate phosphorus, total nitrogen and other nutrients	nd1	nd1	nd4

Notes: Not applicable for crop production because fertiliser application is a standard management practice.
For dryland sown pastures, nitrogen and phosphorus deficiencies reduce the quantity and quality of dry matter.
Low bicarbonate phosphorus 10 - 20 mg/kg, very low < 10 mg/kg.
Low total nitrogen 0.05 - 0.15% , very low < 0.05%.
Other nutrients for example total sulfur, very low levels below 0.005%.

WETNESS (w)

Attribute	Suitability subclass					
	Plantation, Tree and Vine Crops			Vegetable Crops	Sown Pastures	
Drainage class (McDonald and Isbell 1990)	**Fig, Persimmon, Citrus, Stonefruit, Lychee, Pineapple, Macadamia, Mango, Carambola, Passionfruit.**	**Custard apple, Papaw.**	**Avocado, Grape.**	**Cucurbits, Capsicum, Tomato.**	**Setaria.**	**Green panic, Rhodes, Stylo, Silk sorghum, Annual sorghum**
6 (rapidly drained)	w1	w1	w1	w1	w1	w1
5 (well drained)	w1	w1	w2	w1	w1	w1
4 (moderately well drained)	w3	w4	w5	w3	w1	w1
3 (imperfectly drained)	w4	w5	w5	w5	w1	w3
2 (poorly drained)	w5	w5	w5	w5	w3	w5
1 (very poorly drained)	w5	w5	w5	w5	w5	w5

Notes:

Wetness is determined by soil and site drainage.
Heavy clay soils with high water retention are allocated subclass 5 for crop production, irrespective of site characteristics.
Sodic / magnesic texture contrast soils are allocated subclass 5 for pineapple and vegetable crop production if surface thickness is < 0.3m.
The minimum depth of well drained soil needed for avocado and grape is 1.5m, 0.5 to 1 m for all other tree and vine crops and 0.3 - 0.5m for vegetable crops (Macleod and Mead 1986a, 1986b, 1987, 1988, Macleod and Paterson 1990a, 1990b, 1991, Macleod and Perrett 1988, 1989, O'Hare 1980).

FLOODING (f)

Attribute	Suitability subclass		
	Plantation, Tree and Vine Crops	**Vegetable Crops**	**Sown Pastures**
Flood frequency	**Fig, Persimmon, Citrus, Grape, Stonefruit, Custard apple, Avocado, Papaw, Pineapple, Lychee, Macadamia, Mango, Carambola, Passionfruit.**	**Cucurbits, Capsicum, Tomato.**	**Green panic, Rhodes, Stylo, Silk sorghum, Annual sorghum, Setaria.**
flood free	f1	f1	f1
< 1 in 10 years	f2	f2	f2
1 in 5 to 1 in 10 years	f3	f3	f3
> 1 in 5 years	f4	f4	f4

Notes: There is no recorded occurrence of annual flooding. Erosive flooding is restricted to creek terraces. Inundation periods are of short duration.
Crop and pasture damage caused by waterlogging is not covered by this limitation, but assessed in the **wetness** limitation (site component of drainage class).

SURFACE CONDITION (ps)

Attribute	Suitability subclass			
	Plantation, Tree and Vine Crops		Vegetable Crops	Sown Pastures
Soil structure, texture, consistence.	**Fig, Persimmon, Citrus, Grape, Stonefruit, Custard apple, Avocado, Papaw, Pineapple, Lychee, Mango, Carambola, Passionfruit.**	**Macadamia.**	**Cucurbits, Capsicum, Tomato.**	**Green panic, Rhodes, Stylo, Silk sorghum, Annual sorghum, Setaria.**
fine soil surface structure or sand	ps1	ps1	ps1	ps1
coarse soil surface structure	ps1	ps1	ps2	ps2
hardsetting surface soils	ps1	ps1	ps3	ps3
very hardsetting or crusting surface soils	ps1	ps1	ps4	ps4
loose soil surface	ps1	ps5	ps1	ps1

Notes: A loose soil surface (for example fine sand) presents an extreme limitation for mechanical harvesting (vacuum and finger rake) of macadamia nuts.
For vegetable crops and sown pastures, very hardsetting and crusting surface soils affect production by reducing water entry, restricting soil aeration, providing poor soil seed contact and impeding seedling emergence.

SOIL WORKABILITY (k)

Attribute	Suitability subclass			
	Plantation, Tree and Vine Crops		Vegetable Crops	Sown Pastures
Soil texture, structure, consistence, abrasiveness	**Fig, Persimmon, Citrus, Grape, Stonefruit, Custard apple, Avocado, Lychee, Macadamia, Mango, Carambola, Passionfruit.**	**Pineapple, Papaw.**	**Cucurbits, Capsicum, Tomato.**	**Green panic, Rhodes, Stylo, Silk sorghum, Annual sorghum, Setaria.**
sands, structured loams, self mulching clays	k1	k1	k1	k1
hardsetting fine sandy loams to silty clay loams	k1	k2	k2	k1
very hardsetting surface soils or medium - heavy clays	k1	k3	k3	k3
gravelly abrasive soils	k1	k3	k4	k4
heavy clays	k1	k3	k4	k4

Notes: Applied where tillage is carried out for seedbed preparation, planting, weed control and renovation. Abrasiveness affects implement wear.

WATER EROSION (e)

Attribute	Suitability subclass			
	Plantation, Tree and Vine Crops		Vegetable Crops	Sown Pastures
Modal slope angle	Fig, Persimmon, Citrus, Grape, Stonefruit, Custard apple, Avocado, Papaw, Lychee, Macadamia, Mango, Carambola, Passionfruit.	Pineapple.	Cucurbits, Capsicum, Tomato.	Green panic, Rhodes, Stylo, Silk sorghum, Annual sorghum, Setaria.
< 2%	e1	e1	e1	e1
2 - 5%	e1	e2	e2	e1
5 - 8%	e2	e3	e3	e2
8 - 12%	e3	e4	e4	e3
12 - 15%	e3	e4	e5	e3
15 - 20%	e4	e5	e5	e4
> 20%	e5	e5	e5	e5

Notes: The upper slope limit for cultivated land using cover crops is recommended at 8% (O'Hare 1980), but steeper slopes are used in conjunction with a permanent grass sward for plantation, tree and vine crops.

WIND EROSION (a)

Attribute	Suitability subclass			
	Plantation, Tree and Vine Crops		Vegetable Crops	Sown Pastures
Surface texture, coherence	**Fig, Persimmon, Citrus, Grape, Stonefruit, Custard apple, Avocado, Papaw, Lychee, Macadamia, Mango, Carambola, Passionfruit.**	**Pineapple.**	**Cucurbits, Capsicum, Tomato.**	**Green panic, Rhodes, Stylo, Silk sorghum, Annual sorghum, Setaria.**
coherent soil surface	a1	a1	a1	a1
loose fine to medium grain sands	a4	a5	a5	a4

Notes:

Tillage for crop and pasture production provide opportunities for soil loss.
Frequent tillage increases the susceptibility of the soil surface to wind erosion.
Extended periods of low rainfall, high temperatures, and high wind velocity contribute to the severity of wind erosion on a bare soil surface.
Applied at locations where management inputs required to reduce the erosion risk during establishment are considered uneconomic.

ROCKINESS (r)

Attribute	Suitability subclass				
	Plantation, Tree and Vine Crops			Vegetable Crops	Sown Pastures
Coarse fragment size and abundance	Fig, Persimmon, Citrus, Grape, Stonefruit, Custard apple, Avocado, Papaw, Lychee, Mango, Carambola, Passionfruit.	Pineapple.	Macadamia.	Cucurbits, Capsicum, Tomato.	Green panic, Rhodes, Stylo, Silk sorghum, Annual sorghum, Setaria.
No coarse fragments or gravel < 20 mm size.	r1	r1	r1	r1	r1
Gravel: (20 - 60 mm)					
< 2%	r1	r1	r2	r2	r1
2 - 10 %	r1	r1	r3	r3	r1
10 - 20 %	r1	r2	r4	r4	r1
20 - 50 %	r1	r3	r5	r5	r2
> 50%	r2	r4	r5	r5	r3
Cobble: (60 - 200 mm)					
< 2%	r1	r1	r3	r3	r2
2 - 10 %	r2	r2	r5	r4	r2
10 - 20 %	r3	r3	r5	r5	r3
20 - 50 %	r4	r5	r5	r5	r4
> 50%	r5	r5	r5	r5	r5
Stone: (200 - 600 mm)					
< 2%	r1	r3	r3	r4	r3
2 - 10 %	r2	r4	r5	r5	r4
10 - 20 %	r3	r5	r5	r5	r5
> 20%	r5	r5	r5	r5	r5

Notes: Assessed on the presence of coarse fragments within the plough zone (0 - 20 cm) depth.
For macadamia, surface coarse fragments restrict mechanical harvesting (Macleod and Mead 1986a). Effects of rockiness on abrasion and soil water storage are components of the soil workability and water availability limitations. Where combinations occur the most severe attribute level is applied. Subclasses after Wilson and Baker (1990).

SLOPE (ts)

Attribute	Suitability subclass		
	Plantation, Tree and Vine Crops	**Vegetable Crops**	**Sown Pastures**
Modal slope angle	**Fig, Persimmon, Citrus, Grape, Stonefruit, Custard apple, Avocado, Papaw, Pineapple, Lychee, Macadamia, Mango, Carambola, Passionfruit.**	**Cucurbits, Capsicum, Tomato.**	**Green panic, Rhodes, Stylo, Silk sorghum, Annual sorghum, Setaria.**
< 12 %	ts1	ts2	ts1
12 - 15 %	ts3	ts5	ts2
15 - 20 %	ts4	ts5	ts4
> 20%	ts5	ts5	ts5

Notes: Slopes > 12%, where machinery operations are undertaken frequently, are regarded as unsafe for machinery use.
Slopes greater than 20% are regarded as unsafe for machinery use even when infrequent (Land Resources Branch Staff (1990), Vock and Chapman (1994)).

TOPOGRAPHIC COMPLEXITY (xt)

Attribute	Suitability subclass		
	Plantation, Tree and Vine Crops	Vegetable Crops	Sown Pastures
Land surface	**Fig, Persimmon, Citrus, Grape, Stonefruit, Custard apple, Avocado, Papaw, Pineapple, Lychee, Macadamia, Mango, Carambola, Passionfruit.**	**Cucurbits, Capsicum, Tomato.**	**Green panic, Rhodes, Stylo, Silk sorghum, Annual sorghum, Setaria.**
no dissection	xt1	xt1	xt1
very weakly dissected land	xt2	xt2	xt1
weakly dissected land	xt3	xt3	xt2
moderately dissected land, complex slopes	xt4	xt4	xt3
strongly dissected land, steep complex slopes and crests	xt5	xt5	xt4

Notes: Subclasses established for 1:50 000 scale mapping only.
Larger mapping scales, for example 1:10 000, allow separation of topographic components.

APPENDIX II

Morphological and Analytical Data

SOIL NAME: **Awoonga** SITE NO: **1019**

SUBSTRATE MATERIAL: Sedimentary rocks SLOPE: 2.0%

AMG REFERENCE: 3109978 mE 7350914 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Gently undulating rises

AUSTRALIAN CLASSIFICATION: Eutrophic, Mottled Hypernatric, Brown Sodosol; thin, slightly gravelly, loamy, clayey, deep

VEGETATION STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES*: Eucalyptus moluccana, Eucalyptus crebra*

SURFACE COARSE FRAGMENTS: Very few medium angular gravels

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .09 m	Very dark greyish brown (10YR3/2) moist; loam; few medium angular gravels ; weak 5-10mm subangular blocky; moist moderately weak. Sharp to-
A2e	.09 to .22 m	Light grey (10YR7/2) dry; clay loam; common large angular gravel; massive moist moderately weak. Abrupt to-
B21	.22 to .40 m	Yellowish brown (10YR5/8) moist; common coarse distinct grey mottles; medium heavy clay; few medium angular gravels; moderate 50-100mm prismatic; moist very firm. Gradual to-
B22	.40 to .70 m	Yellowish brown (10YR5/6) moist; common medium distinct grey mottles; medium heavy clay; very few medium angular gravels; moderate 20-50mm angular blocky; moderately moist very firm. Gradual to-
B23	.70 to 1.50 m	Light yellowish brown (10YR6/4); many coarse distinct grey mottles; medium clay; few medium angular gravels; moderate 10-20mm angular blocky; moderately moist moderately firm.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC dS/m	Cl %	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
				% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.1	.05	.002																
0.10	6.2	.06	.002	19	29	26	23	16	7.6	3.2	.20	.30			2.4	12	.048	.382	.033
0.30	6.5	.34	.032	15	14	37	36	24	4.3	12	5.5	.07			4.6	21	.010	.313	.038
0.60	8.9	.71	.076	11	21	25	45	24	5.3	13	9.3	.05			4.7	21	.008	.395	.022
0.90	8.8	.77	.101	14	20	26	41	25	5.9	12	11	.05			4.4	21	.010	.311	.014
1.20	8.5	.69	.093	11	22	31	38	22	9.6	11	10	.04			4.4	21	.012	.438	.011
1.50	8.1	.63	.094					25	7.3	14	10	.02				22			

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			mg/kg			ppm				
B.10	2.5	.15	13	9	.43	67	32	.58	1.4	7

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Bayfield** SITE NO: **587**

SUBSTRATE MATERIAL: Sedimentary rocks SLOPE: 2.5%

AMG REFERENCE: 262 211 mE 7 470 173 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Rises

AUSTRALIAN CLASSIFICATION: Bleached-Mottled, Magnesic, Red, Kurosol; medium, non gravelly, loamy, clayey, deep

VEGETATION STRUCTURAL FORM: Tall woodland

DOMINANT SPECIES: *Eucalyptus umbra, Corymbia intermedia, Casuarina torulosa, Banksia integrifolia*

SURFACE COARSE FRAGMENTS: No coarse fragments

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .08 m	Light brownish grey (2.5Y6/2) moist; fine sandy loam; massive; moderately moist; moderately weak. Sharp to-
A2e	.08 to .30 m	Pale yellow (2.5Y7/4) dry; fine sandy clay loam; very few medium gravels, subangular ironstone; massive; moderately moist; moderately weak. Clear to-
B21	.30 to .70 m	Red (2.5YR4/6) moist; common coarse distinct brown mottles; medium clay; very few large gravels, subangular ironstone; moderate 5-10mm polyhedral; moist; moderately firm. Gradual to-
B22	.70 to 1.30 m	Brown (7.5YR4/4) moist; common medium distinct red mottles; medium clay; weak 5-10mm polyhedral; moist; moderately firm. Gradual to-
B3	1.30 to 1.50 m	Grey (10YR6/1) moist; common medium distinct brown mottles; medium clay; very few medium gravels, angular ironstone; weak 5-10mm polyhedral; moist; moderately firm.

LABORATORY DATA:

Depth	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
(m)	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	5.8	.02	.002																
0.10	5.8	.01	.002	5	67	20	9	1	.18	.79	.19	.02			1.3	3	.005	.062	.012
0.30	5.3	.01	.001	3	65	16	19	1	.06	.70	.12	.01			1.7	6	.007	.088	.014
0.60	4.8	.04	.004	2	43	14	44	7	.09	2.3	.22	.04	2.7	3.4	6.3	15	.008	.285	.036
0.90	5.0	.02	.002	1	49	19	29	6	.07	1.7	.17	.02	2.2	3.2	3.5	11	.006	.222	.026
1.20	5.0	.02	.002	1	51	29	23	4	.07	1.0	.14	.01			2.7	9	.005	.172	.022
1.50	4.9	.03	.002																

Depth	Org C	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
(m)	W & B	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
	%		mg/kg			ppm				
B.10	1.5	.04	4	1	.01	52	.67	.02	.11	5

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Beaks** SITE NO: **1133**

SUBSTRATE MATERIAL: Volcanic rocks SLOPE: 42%

AMG REFERENCE: 263226 mE 7454282 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Steep hills

AUSTRALIAN CLASSIFICATION: Haplic, Eutrophic, Red Kandosol; medium, very gravelly, loamy, clayey, moderate

VEGETATION STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: *Eucalyptus acmenoides, Corymbia intermedia, Casuarina torulosa*

SURFACE COARSE FRAGMENTS: Common large gravel, angular

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Soft

HORIZON	DEPTH	DESCRIPTION
A11	0 to .15 m	Brownish black (5YR3/1) moist; loam; many large gravels, angular; strong 2-5mm granular; moist very weak. Gradual to-
A12	.15 to .35 m	Reddish brown (5YR4/3) moist; sandy clay loam; many large gravels, angular; massive; moist very weak. Gradual to
B21	.35 to .70 m	Reddish brown (5YR4/4) moist; sandy light clay; many large gravels, angular; massive; moist moderately weak. Gradual to-
B22	.70 to .90 m	Reddish brown (5YR5/4) moist; few medium faint yellow mottles; sandy light medium clay; many large gravels, angular; massive; moist moderately firm. Gradual to-
BC	.90 to 1.20 m	Brown (7.5YR4/6) moist; sandy clay loam; abundant coarse gravel; massive; moist very firm.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC dS/m	Cl %	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
				% @ 105C				meq per 100g soil							% at 105C		%		
B.10	5.5	.05	.004																
0.10	5.4	.05	.005	28	37	16	17	9	3.3	4.2	.35	.24	1.0	1.0	2.4	11	.039	1.83	.042
0.30	5.9	.02	.002	31	32	13	20	6	1.2	3.4	.19	.26	1.0	1.0	2.1	9	.037	2.12	.029
0.60	5.9	.02	.002	34	28	14	21	7	.48	4.2	.15	.14	2.4	2.4	2.4	10	.059	2.56	.036
0.90	5.5	.03	.003	26	26	15	32	15	.15	7.3	.36	.09	6.6	6.9	3.6	14	.049	2.62	.031
1.20	5.4	.03	.004	29	28	14	29	14	BQ	6.5	.51	.09	6.9	7.4	3.0		.067	1.91	.043

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			mg/kg			ppm				
B.10	4.4	.27	6	10	.38	138	7.4	1.3	.33	7.0

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Benaraby** SITE NO: **415**

SUBSTRATE MATERIAL: Alluvium SLOPE: 3.0%

AMG REFERENCE: 328 960 mE 7 340 707 mN ZONE 56

LANDFORM ELEMENT TYPE: Levee LANDFORM PATTERN TYPE: Alluvial plain

AUSTRALIAN CLASSIFICATION: Haplic, Eutrophic, Brown, Kandosol; thick, non gravelly, loamy, clay loamy, very deep

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
Ap	0 to .20 m	Very dark greyish brown (10YR3/2) moist; fine sandy loam; massive, parting to weak 2-5mm granular; moist; very weak. Gradual to-
A12	.20 to .40 m	Very dark greyish brown (10YR3/2) moist; fine sandy loam; massive; moist; very weak. Gradual to-
B21	.40 to 1.20 m	Dark yellowish brown (10YR4/4) moist; fine sandy clay loam; massive; moist; very weak. Diffuse to-
B22	1.20 to 1.60 m	Brown (7.5YR4/4) moist; fine sandy clay loam; massive; moist; very weak.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	7.4	.06	.004																
0.10	7.0	.10	.009	19	56	11	15	7	3.3	2.2	.76	.34			1.4	6	.071	1.84	.019
0.30	7.0	.05	.004	18	57	13	14	5	3.6	.88	.59	.13			0.9	6	.060	1.83	.011
0.60	6.8	.06	.005	19	51	14	19	6	4.4	1.4	.58	.10			1.3	7	.065	1.86	.010
0.90	6.8	.06	.005	22	49	9	20	7	4.4	1.6	.55	.13			1.1	8	.065	1.93	.008
1.20	6.7	.06	.007	17	58	11	16	6	3.7	1.9	.44	.10			1.0		.051	1.92	.006
1.50	6.7	.08	.008																

Depth (m)	Org C W & B	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
	%	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
			mg/kg			ppm				
B.10	1.3	.08	137	57	.51	49	7.5	.64	1.9	3

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Bompa** SITE NO: **133**

SUBSTRATE MATERIAL: Volcanic rocks SLOPE: 4.0%

AMG REFERENCE: 316 676 mE 7 347 931 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Undulating rises

AUSTRALIAN CLASSIFICATION: Melanic, Eutrophic, Brown, Dermosol; slightly gravelly, fine, medium fine, moderate

VEGETATION STRUCTURAL FORM: Tall woodland

DOMINANT SPECIES: *Eucalyptus crebra, Corymbia intermedia, Acacia aulacocarpa, Heteropogon triticeus, Heteropogon contortus*

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A11	0 to .03 m	Very dark greyish brown (10YR3/2) moist; light clay; few medium gravels, angular; moderate 2-5mm granular; moist; loose. Sharp to-
A12	.03 to .20 m	Very dark greyish brown (10YR3/2) moist; light clay; few large gravels, angular; massive parting to moderate 5-10mm subangular blocky; moist; moderately weak. Clear to-
B21	.20 to .45 m	Dark yellowish brown (10YR4/6) moist; medium clay; very few medium gravels, angular; moderate 20-50mm angular blocky; moderately moist; very firm; very few medium manganiferous soft segregations. Gradual to-
B22	.45 to .65 m	Light olive brown (2.5Y5/5) moist; light medium clay; very few medium gravels, angular; moderate 50-100mm lenticular; moderately moist; moderately firm; very few medium manganiferous soft segregations. Gradual to-
BC	.65 to .85 m	Greyish brown (2.5Y5/3) moist; sandy light clay; many large gravels, angular; weak 10-20mm angular blocky; moderately moist; moderately weak; very few manganiferous veins.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC dS/m	Cl %	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
				% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.7	.05	.004																
0.10	6.1	.04	.003	30	18	21	35	17	10	6.6	.29	.19	.10	.10	4.9	15	.039	.137	.049
0.30	5.8	.07	.005	10	10	11	68	25	13	11	.95	.01	.30	.40	8.5	27	.019	.040	.037
0.60	6.3	.09	.010	17	11	17	55	27	15	11	1.4	.02			7.2	21	.013	.072	.031
0.85	7.0	.07	.007	37	15	17	32	29	16	11	1.5	.01			4.2	15	.016	.181	.026

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq	Rep K. %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			Mg/kg				ppm				
B.10	1.3	.05		6	.30		58	25	2.7	1.1	

- Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Boyanda** SITE NO: **210**

SUBSTRATE MATERIAL: Alluvium SLOPE: 0.5%

AMG REFERENCE: 330 650 mE 7 344 415 mN ZONE 56

LANDFORM ELEMENT TYPE: Terrace LANDFORM PATTERN TYPE: Gently undulating plain

AUSTRALIAN CLASSIFICATION: Basic, Regolithic, Orthic, Tenosol; thick, non gravelly, sandy, sandy, deep

VEGETATION STRUCTURAL FORM: Tall isolated trees

DOMINANT SPECIES: *Corymbia tessellaris, Heteropogon triticeus, Aristida species*

SURFACE COARSE FRAGMENTS: No coarse fragments

TYPE OF MICRORELIEF: No microrelief

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Soft

HORIZON	DEPTH	DESCRIPTION
A1	0 to .32 m	Very dark greyish brown (10YR3/2) moist; loamy sand; massive; moist; very weak. Gradual to-
B2	.32 to .75 m	Dark yellowish brown (10YR4/4) moist; loamy sand; massive; moist; very weak. Gradual to-
BC	.75 to 1.30 m	Yellowish brown (10YR5/4) moist; loamy sand; massive; moderately moist; very weak. Diffuse to-
C	1.30 to 1.60 m	Yellowish brown (10YR5/4) moist; clayey sand; very few medium gravels, rounded; massive; moderately moist; moderately weak.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.1	.05	.001																
0.10	5.8	.29	.003	52	33	5	10	10	6.7	2.2	.15	.99	BQ	BQ	0.8	7	.083	1.61	.050
0.30	6.1	.03	.001	58	33	5	6	6	3.8	1.3	.05	.39			0.7	4	.066	1.64	.016
0.60	6.5	.02	.001	46	45	5	6	4	2.9	1.1	.05	.40			0.6	4	.050	1.67	.009
0.90	6.6	.01	.001	34	53	7	9	4	2.3	1.2	.03	.23			0.7	4	.041	1.61	.007
1.20	6.4	.01	.001	35	51	7	9	5	2.8	1.5	.09	.19			0.7	5	.043	1.56	.006
1.50	6.6	.01	.001	44	41	7	12	6	3.3	2.0	.18	.09			0.9	5	.042	1.57	.006

Depth (m)	Org C W & B	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
	%	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
			mg/kg			ppm				
B.10	1.6	.11	157	26	.72	49	9.0	.20	2.6	2

- Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Broughton** SITE NO: **593**

SUBSTRATE MATERIAL: Granite SLOPE: 2.0%

AMG REFERENCE:259 182 mE 7 473 955 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Rises

AUSTRALIAN CLASSIFICATION: Reticulate, Mesotrophic, Grey, Kurosol; very thick, non gravelly, sandy, clayey, very deep

VEGETATION STRUCTURAL FORM: Tall open woodland

DOMINANT SPECIES: *Syncarpia glomulifera, Eucalyptus acmenoides, Casuarina torulosa, Banksia integrifolia*

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A11	0 to .10 m	Dark greyish brown (10YR4/2) moist; loamy sand; massive; moist; very weak. Clear to-
A12	.10 to .20 m	Greyish brown (10YR5/2) moist; loamy sand; massive; moist; very weak. Clear to-
A21	.20 to .50 m	Pale yellow (2.5Y7/5) moist; loamy sand; massive; moist; very weak. Gradual to-
A22	.50 to .70 m	Brownish yellow (10YR6/6) moist; coarse sandy loam; common small gravels, rounded; massive; moist; very weak. Clear to-
B21	.70 to 1.10 m	Grey (10YR6/1) moist; common medium prominent red mottles; coarse sandy medium clay; moderate 20-50mm angular blocky; moist; moderately firm; very few medium ferruginous soft segregations. Gradual to-
B22	1.10 to 1.55 m	Grey (10YR5/1) moist; very few medium prominent red mottles; coarse sandy medium heavy clay; weak 50-100mm lenticular, parting to moderate 20-50mm angular blocky; moist; moderately firm.

LABORATORY DATA:

Depth	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
(m)	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	5.9	.04	.004																
0.10	6.2	.02	.002	35	51	5	9	2	.96	1.1	.13	.10			3.1	4	.007	.085	.023
0.30	6.0	.01	.001	31	54	4	9	1	.14	.71	.13	.04			1.0	3	.004	.064	.011
0.60	5.6	.01	.002	41	41	7	12	1	.11	1.2	.10	.02			0.9	4	.003	.050	.014
0.90	5.3	.04	.006	37	13	4	46	6	.10	2.4	.24	.02	1.7	2.7	7.3	16	.005	.103	.040
1.20	5.3	.07	.011	42	12	5	44	6	.09	2.5	.38	.01	1.7	2.8	6.4	15	.003	.144	.031
1.50	5.3	.14	.020																

Depth	Org C	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
(m)	W & B	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
	%		mg/kg			ppm				
B.10	1.5	.05	1	1	.05	53	1.8	.01	.28	5

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Cassandra** SITE NO: **134**

SUBSTRATE MATERIAL: Alluvium SLOPE: 0.0%

AMG REFERENCE: 320 287 mE 7 347 670 mN ZONE 56

LANDFORM ELEMENT TYPE: Plain LANDFORM PATTERN TYPE: Alluvial plain

AUSTRALIAN CLASSIFICATION: Endohypersodic, Epipedal, Brown, Vertosol; non gravelly, medium fine, very fine, very deep

VEGETATION STRUCTURAL FORM: Tall open woodland

DOMINANT SPECIES: *Eucalyptus tereticornis, Dichanthium sericeum, Heteropogon contortus*

SURFACE COARSE FRAGMENTS: No coarse fragments

TYPE OF MICRORELIEF: Normal gilgai Vertical Interval 0.30 m Horizontal Interval 5 m Shelf sampled

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Very dark greyish brown (10YR3/2) moist; medium clay; moderate 10-20mm angular blocky; dry; very firm. Sharp to-
B21	.10 to .40 m	Dark brown (10YR3/3) moist; heavy clay; moderate 20-50mm angular blocky; moderately moist; very firm; few medium manganiferous nodules. Gradual to-
B22	.40 to .90 m	Very dark grey (10YR3/1) moist; heavy clay; strong 50-100mm lenticular, parting to strong 5-10mm lenticular; moist; moderately firm; few medium manganiferous nodules. Gradual to-
B23	.90 to 1.20 m	Dark grey (10YR4/1) moist; heavy clay; moderate 50-100mm lenticular, parting to strong 5-10mm lenticular; moist; moderately firm; few medium manganiferous nodules. Gradual to-
B24k	1.20 to 1.65 m	Dark grey (10YR4/1) moist; few medium faint yellow mottles; medium heavy clay; strong 2-5mm lenticular; moist; moderately firm; few coarse calcareous nodules, very few medium manganiferous nodules.

LABORATORY DATA:

Depth	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
(m)	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.2	.06	.004																
0.10	6.3	.10	.008	3	19	29	50	29	15	13	.66	.38			5.8	22	.036	.309	.054
0.30	6.9	.07	.006	2	17	24	58	32	15	15	1.5	.13			7.0	23	.018	.241	.032
0.60	7.6	.64	.079	2	12	22	61	48	17	21	4.8	.08			9.4	26	.016	.268	.036
0.90	8.0	1.3	.161	3	17	24	60	47	15	21	7.2	.07			10.6	26	.014	.265	.034
1.20	8.2	1.5	.210	3	19	23	59	45	14	20	8.8	.07			10.8		.014	.251	.035
1.50	8.8	1.4	.173																

Depth	Org C	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
(m)	W & B	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
	%		Mg/kg			ppm				
B.10	2.8	.16	4		.39	143	92	4.8	1.5	

- Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Conway** SITE NO: **412**

SUBSTRATE MATERIAL: Sedimentary rocks SLOPE: 7.0%

AMG REFERENCE: 329 157 mE 7 349 210 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Undulating rises

AUSTRALIAN CLASSIFICATION: Magnesic, Mottled-Subnatric, Red, Sodosol; medium, moderately gravelly, loamy, clayey, moderate

VEGETATION STRUCTURAL FORM: Tall woodland

DOMINANT SPECIES: *Corymbia citriodora, Eucalyptus crebra, Eucalyptus exserta, Acacia conferta*

SURFACE COARSE FRAGMENTS: Common large gravel, angular chert

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Very dark greyish brown (10YR3/2) moist; sandy loam; many medium gravels, angular chert; massive; dry; moderately weak. Clear to-
A2e	.10 to .26 m	Yellowish brown (10YR5/4) moist, light grey (10YR7/2) dry; sandy clay loam; abundant medium gravels, angular chert; massive; dry; moderately weak. Clear to-
B21	.26 to .43 m	Reddish brown (2.5YR4/4) moist; common medium distinct grey mottles; medium clay; very few medium gravels, angular chert; moderate 10-20mm angular blocky; dry; very firm. Gradual to-
B22	.43 to .60 m	Brown (7.5YR5/4) moist; common coarse distinct grey mottles; light medium clay; very few medium gravels, angular chert; moderate 20-50mm angular blocky; dry; moderately strong.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water pH	EC dS/m	Cl %	Particle Size CS	FS	Si	C % @ 105C	Exchangeable Cations* CEC	Ca	Mg	Na	K	Al	Acid meq per 100g soil	Moistures ADM	15mP % at 105C	Total Element P	K	S %
B.10	5.8	.04	.005																
0.10	5.6	.06	.008	24	45	25	11	6	3.1	2.6	.38	.21	.20	.20	1.2	5	.021	.540	.024
0.20	5.3	.04	.006																
0.40	5.5	.04	.005										4.0	4.8					
0.60	5.2	.09	.014	6	24	33	40	13	.14	12	.94	.16			3.3	17	.009	1.68	.010

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Bicarb mg/kg	Rep K. meq %	DTPA extr. Fe	Mn	Cu	Zn ppm	SO4-S ppm
B.10	3.4	.15	11	22	.35	48	26	.31	1.5	4

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Conway** SITE NO: **384**

SUBSTRATE MATERIAL: Sedimentary rocks SLOPE: 3.0%

AMG REFERENCE: 329 680 mE 7 344 177 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Undulating rises

AUSTRALIAN CLASSIFICATION: Bleached, Magnesic, Red, Kurosol; thick, moderately, gravelly, loamy, clayey, deep

VEGETATION STRUCTURAL FORM: Tall isolated trees

DOMINANT SPECIES: *Corymbia citriodora, Eucalyptus crebra*

SURFACE COARSE FRAGMENTS: Few large gravels, angular chert

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A11	0 to .12 m	Very dark greyish brown (10YR3/2) moist; sandy loam; common large gravels, angular chert; weak 5-10mm subangular blocky; dry; moderately firm. Clear to-
A12	.12 to .45 m	Brown (7.5YR5/3) moist; loamy coarse sand; abundant large gravels, angular chert; massive; dry; moderately weak. Gradual to-
A2e	.45 to .60 m	Pinkish grey (7.5YR7/2) dry; sandy loam; many medium gravels, angular chert; massive; dry; moderately weak. Clear to-
B2	.60 to .90 m	Reddish brown (2.5YR4/4) moist; common medium distinct brown mottles; light medium clay; very few medium gravels, angular chert, very few medium gravels, angular detrital sedimentary rock (unidentified); moderate 20-50mm angular blocky; moist; moderately firm. Gradual to-
B31	.90 to 1.30 m	Grey (7.5YR6/1) moist; common coarse prominent red mottles; light medium clay; common large gravels, angular chert; weak 20-50mm angular blocky; moist; moderately firm. Gradual to-
B32	1.30 to 1.50 m	Grey (10YR6/1) moist; common medium prominent red mottles; light medium clay; common large gravels, angular chert; weak 20-50mm angular blocky; moist; moderately firm.

LABORATORY DATA:

Depth	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
(m)	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	5.7	.05	.000										BQ	BQ					
0.10	6.1	.02	.000	44	40	9	10	4	2.4	1.3	.13	.12	BQ	BQ	0.7	3	.031	.179	.019
0.30	5.6	.01	.000	48	33	7	14	2	.51	.75	.07	.10	.50	.70	0.7	5	.030	.183	.009
0.60	5.5	.01	.000	52	29	12	10	2	.27	.69	.07	.06	.50	.70	0.4	4	.018	.159	.008
0.90	5.3	.02	.001	22	14	7	58	12	.14	4.8	.24	.11	5.2	6.6	2.8	20	.017	.636	.015
1.20	5.2	.02	.001	24	11	6	59	14	.08	4.7	.29	.10	7.0	9.3	3.9		.014	.677	.019
1.50	5.0	.02	.001										9.0	11.1					

Depth	Org C	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
(m)	W & B	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
	%		mg/kg			ppm				
B.10	1.9	.07	15	16	.28	33	20	.13	.52	6

- Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Coorooman** SITE NO: **26**

SUBSTRATE MATERIAL: Chert SLOPE: 31%

AMG REFERENCE: 318 037 mE 7 350 852 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Steep hills

AUSTRALIAN CLASSIFICATION: Haplic, Dystrophic, Red, Kandosol; medium, very gravelly, loamy, clayey, moderate

VEGETATION STRUCTURAL FORM: Tall woodland

DOMINANT SPECIES: *Corymbia citriodora, Corymbia intermedia, Eucalyptus crebra, Lophostemon confertus, Xanthorrhoea johnsonii*

SURFACE COARSE FRAGMENTS: Common large gravel, angular chert

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A1	0 to .15 m	Dark brown (7.5YR3/2); coarse sandy loam; many large gravels, angular chert; massive; dry; very weak. Clear to-
A2	.15 to .30 m	Brown (7.5YR4/2); sandy clay loam; common large gravels, angular chert; massive; dry; moderately weak. Gradual to-
B2	.30 to .80 m	Reddish brown (5YR4/4); sandy light clay; many cobbles, angular chert; massive; dry; moderately weak.

LABORATORY DATA:

Depth	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
(m)	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	5.4	.05	.004																
0.10	5.7	.02	.001	43	20	27	11	5	1.4	1.8	.10	.21	.60	1.0	1.3	8	.032	.274	.039
0.30	6.1	.01	.001	31	23	29	16	2	.02	1.0	.10	.12	.60	.80	0.7	8	.023	.252	.027
0.60	5.9	.01	.001	28	20	27	25	1	.01	.63	.06	.04	.60	.70	0.3	7	.022	.275	.023

Depth	Org C	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
(m)	W & B	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
	%		Mg/kg			ppm				
B.10	1.6	.17		16	.28	91	130	.36	.61	

- Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Corduroy** SITE NO: **289**

SUBSTRATE MATERIAL: Alluvium SLOPE: 0.5%

AMG REFERENCE: 262 192 mE 7 441 501 mN ZONE 56

LANDFORM ELEMENT TYPE: Plain LANDFORM PATTERN TYPE: Alluvial plain

AUSTRALIAN CLASSIFICATION: Melanic-Sodic, Calcic, Black, Dermosol; medium, non gravelly, clay loamy, clayey, very deep

VEGETATION STRUCTURAL FORM: Tall isolated trees

DOMINANT SPECIES: *Corymbia tessellaris, Eucalyptus tereticornis, Lophostemon suaveolens*

SURFACE COARSE FRAGMENTS: No coarse fragments

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A1	0 to .20 m	Black (10YR2/1) moist; clay loam; moderate 10-20mm subangular blocky; moist; moderately weak. Gradual to-
B21	.20 to .65 m	Very dark grey (10YR3/1) moist; light clay; strong 10-20mm angular blocky; moist; moderately weak. Diffuse to-
B22	.65 to 1.30 m	Dark grey (10YR4/1) moist; few medium distinct yellow mottles; medium clay; moderate 50-100mm lenticular, parting to strong 5-10mm lenticular; moist; moderately firm; very few medium manganiferous nodules. Diffuse to-
B23	1.30 to 1.65 m	Brown (10YR5/3) moist; common medium distinct yellow mottles; sandy medium clay; moderate 20-50mm angular blocky; moist; moderately firm; very few medium manganiferous nodules, few medium calcareous soft segregations.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC dS/m	Cl mg/kg	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
				% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.2	.08	16																
0.10	6.3	.04	7	7	36	30	29	25	6.3	9.8	.31	.20			3.4	14	.031	.163	.036
0.30	6.7	.03	1	10	36	26	30	24	6.6	11	.61	.06			2.9	13	.020	.115	.023
0.60	7.2	.05	25	9	34	24	35	20	6.8	12	1.0	.05			2.5	15	.014	.089	.020
0.90	7.5	.15	144	18	40	16	28	16	5.7	10	1.2	.05			2.1	12	.008	.095	.013
1.20	7.6	.31	343	19	43	15	25	16	4.9	9.4	1.6	.04			2.0	11	.009	.106	.014
1.50	7.6	.46	479	14	42	16	28	19	5.2	11	2.0	.01			2.1	13	.009	.114	.020

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			mg/kg			ppm				
B.10	2.9	.20	10	11	.60	127	42	5.3	2.5	30

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Darts** SITE NO: **403**

SUBSTRATE MATERIAL: Metasediments SLOPE: 25.0%

AMG REFERENCE: 328 060 mE 7 340 635 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Rolling low hills

AUSTRALIAN CLASSIFICATION: Basic, Paralithic, Bleached-Leptic, Tenosol; medium, very gravelly, loamy, shallow

VEGETATION STRUCTURAL FORM: Tall open woodland

DOMINANT SPECIES: *Eucalyptus crebra*

SURFACE COARSE FRAGMENTS: Common cobbles, angular detrital sedimentary rock (unidentified)

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Very dark greyish brown (10YR3/2) moist; sandy loam; many large gravels, angular detrital sedimentary rock (unidentified); weak 2-5mm granular. Gradual to-
A12	.10 to .22 m	Dark greyish brown (10YR4/2) moist; loam; many large gravels, angular detrital sedimentary rock (unidentified); massive. Gradual to-
A2e	.22 to .40 m	Brown (10YR5/3) moist, light grey (10YR7/2) dry; loam; abundant large gravels, angular detrital sedimentary rock (unidentified); massive

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.3	.03	.000																
0.10	6.2	.03	.000	38	19	20	25	9	5.1	2.8	.08	.55			1.4	9	.033	1.87	.030
0.20	5.7	.02	.000										.50	.60					
0.40	5.7	.02	.001	27	21	24	31	6	1.3	2.6	.13	.22	.70	1.4	1.1	8	.020	1.77	.011

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			mg/kg			ppm				
B.10	2.6	.11	28	15	.70	24	25	.25	.61	4

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Diglum** SITE NO: **414**

SUBSTRATE MATERIAL: Alluvium SLOPE: 0.5%

AMG REFERENCE: 328 621 mE 7 341 017 mN ZONE 56

LANDFORM ELEMENT TYPE: Terrace LANDFORM PATTERN TYPE: Alluvial plain

AUSTRALIAN CLASSIFICATION: Melanic, Subnatric, Black, Sodosol; thick, non gravelly, clay loamy, clayey, very deep

VEGETATION STRUCTURAL FORM: Tall isolated trees

DOMINANT SPECIES: *Eucalyptus tereticornis*

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
Ap	0 to .20 m	Very dark greyish brown (10YR3/2) moist; clay loam; massive, parting to moderate 5-10mm subangular blocky; moist; moderately weak. Clear to-
A2j	.20 to .45 m	Dark greyish brown (10YR4/2) dry; silty clay loam; massive; moist; moderately weak. Clear to-
B21	.45 to .70 m	Very dark greyish brown (10YR3/2) moist; medium clay; moderate 20-50mm lenticular; dry; moderately strong. Diffuse to-
B22	.70 to 1.60 m	Very dark grey (10YR3/1) moist; heavy clay; strong 10-20mm lenticular; dry; moderately strong; very few medium calcareous concretions.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	5.9	.07	.002																
0.10	6.0	.04	.002	5	33	35	30	18	11	6.3	.26	.42			4.0	16	.125	1.39	.035
0.30	6.6	.03	.002	3	31	34	33	19	11	7.1	.73	.23			2.6	14	.080	1.32	.011
0.60	7.5	.18	.020	2	25	32	45	28	14	10	2.1	.14			3.7	17	.054	1.26	.010
0.90	8.0	.48	.063	1	28	30	43	26	14	11	3.2	.11			4.0	16	.032	1.28	.010
1.20	8.3	.70	.080	1	22	32	49	30	15	13	4.1	.13			4.1		.030	1.31	.010
1.50	8.2	.60	.078																

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			mg/kg			ppm				
B.10	2.8	.21	97	89	.86	163	47	2.9	4.8	10

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Ebon** SITE NO: **543**

SUBSTRATE MATERIAL: Sedimentary rocks SLOPE: 9.0%

AMG REFERENCE: 270 508 mE 7 429 603 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Rises

AUSTRALIAN CLASSIFICATION: Melanic, Eutrophic, Brown, Chromosol; thick, slightly gravelly, clay loamy, clayey, very deep

VEGETATION STRUCTURAL FORM: Tall isolated trees

DOMINANT SPECIES: *Corymbia citriodora, Corymbia intermedia, Eucalyptus crebra*

SURFACE COARSE FRAGMENTS: Very few cobbles, angular chert

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A11	0 to .20 m	Black (10YR2/1) moist; clay loam; few medium gravels, angular chert; strong 2-5mm granular; moderately moist; moderately weak. Gradual to-
A12	.20 to .36 m	Very dark greyish brown (10YR3/2) moist; clay loam; common large gravels, angular chert; moderate 5-10mm subangular blocky; moderately moist; moderately firm. Clear to-
B21	.36 to .70 m	Yellowish brown (10YR5/6) moist; medium clay; few large gravels, angular chert; moderate 20-50mm angular blocky; moist; moderately firm. Gradual to-
B22	.70 to 1.00 m	Brownish yellow (10YR6/6) moist; few coarse distinct dark mottles; light medium clay; very few medium gravels, angular chert; moderate 20-50mm angular blocky; moist; moderately firm. Gradual to-
B23	1.00 to 1.55 m	Light yellowish brown (10YR6/4) moist; common medium distinct grey mottles; light medium clay; very few medium gravels, angular chert; strong 20-50mm angular blocky; moist; moderately firm.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water pH	EC dS/m	Cl %	Particle Size CS	FS	Si	C (% @ 105C)	Exchangeable Cations* CEC	Ca	Mg	Na	K	Al	Acid (meq per 100g soil)	Moistures ADM	15mP (% at 105C)	Total Element P	K	S (%)
B.10	6.1	.03	.002																
0.10	6.0	.02	.001	25	14	20	40	19	10	8.9	.26	.27			6.4	19	.112	.578	.057
0.30	6.4	.02	.001	24	14	16	45	20	9.9	9.3	.32	.15			6.0	18	.077	.492	.032
0.60	7.1	.03	.001	9	6	19	68	22	5.2	15	1.2	.16			4.5	22	.021	.722	.016
0.90	7.6	.04	.003	6	12	27	54	28	6.1	20	2.3	.06			3.8	17	.008	.906	.008
1.20	8.4	.11	.013	6	17	35	43	29	5.7	20	3.6	.03			3.4	14	.008	1.37	.006
1.50	8.8	.27	.035																

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Bicarb (mg/kg)	Rep K. meq %	DTPA extr. Fe	Mn	Cu	Zn (ppm)	SO4-S ppm
B.10	3.7	.27	9	8	.41	98	114	3.5	5.0	8

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Elizabeth** SITE NO: **248**

SUBSTRATE MATERIAL: Sedimentary rocks SLOPE: 5.0%

AMG REFERENCE: 262 200 mE 7 444 000 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Undulating low hills

AUSTRALIAN CLASSIFICATION: Haplic, Mesotrophic, Red, Kandosol; medium, non gravelly, clay loamy, clayey, very deep

VEGETATION STRUCTURAL FORM: Mid-high tussock grassland

DOMINANT SPECIES: *Chloris gayana, Stylosanthes scabra*

SURFACE COARSE FRAGMENTS: No coarse fragments

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
Ap1	0 to .03 m	Dark reddish brown (5YR3/2) moist; clay loam; moderate 2-5mm granular; moderately moist; moderately weak; few medium manganiferous nodules. Sharp to-
Ap2	.03 to .22 m	Dark reddish brown (5YR3/3) moist; clay loam; massive; moderately moist; moderately firm; few medium manganiferous nodules. Gradual to-
B21	.22 to .70 m	Dark reddish brown (2.5YR3/4) moist; light clay; very few medium gravels, angular chert; weak 5 - 10mm polyhedral; moist; moderately weak. Gradual to-
B22	.70 to 1.00 m	Dark reddish brown (2.5YR3/4) moist; light clay; few large gravels, angular chert; massive; moist; moderately weak. Diffuse to-
B23	1.00 to 1.60 m	Dark reddish brown (2.5YR3/3) moist; light clay; very few large gravels, angular chert; massive; moist; moderately weak.

LABORATORY DATA:

Depth	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
(m)	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.3	.08	.002																
0.10	6.3	.05	.002	16	36	23	30	9	5.3	2.7	.09	.65	BQ	BQ	2.4	11	.055	.178	.045
0.30	6.5	.02	.000	10	33	24	38	6	3.9	1.8	.10	.19	BQ	BQ	2.8	12	.044	.175	.026
0.60	5.9	.03	.001	7	23	16	57	4	2.3	1.9	.17	.11	BQ	BQ	2.5	16	.042	.226	.021
0.90	5.9	.04	.004	7	24	17	56	5	2.2	2.1	.17	.08	BQ	BQ	2.4	16	.037	.197	.017
1.20	6.0	.02	.001	7	25	18	53	4	1.8	2.4	.12	.04	BQ	BQ	3.4		.036	.187	.016
1.50	6.0	.02	.000																

Depth	Org C	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
(m)	W & B	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
	%		mg/kg			ppm				
B.10	3.1	.23	8	8	.76	39	218	3.9	2.2	11

- Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Elizabeth** SITE NO: **331**

SUBSTRATE MATERIAL: Sedimentary rocks SLOPE: 8.0%

AMG REFERENCE: 263 860 mE 7 442 311 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Undulating rises

AUSTRALIAN CLASSIFICATION: Melanic, Mesotrophic, Red, Kandosol; medium, non gravelly, clay loamy, clayey, deep

VEGETATION STRUCTURAL FORM: Tall open forest

DOMINANT SPECIES: *Corymbia intermedia, Lophostemon suaveolens, Eucalyptus tereticornis, Alphitonia excelsa*

SURFACE COARSE FRAGMENTS: No coarse fragments

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Soft

HORIZON	DEPTH	DESCRIPTION
A1	0 to .20 m	Dark brown (7.5YR3/2) moist; clay loam; moderate 2-5mm granular. Gradual to
B21	.20 to .40 m	Reddish brown (5YR4/4) moist; light clay; very few medium gravels, angular chert; massive. Gradual to-
B22	.40 to 1.00 m	Dark red (2.5YR3/6) moist; light medium clay; very few large gravels, angular chert; massive. Diffuse to
B23	1.00 to 1.55 m	Dark red (2.5YR3/6) moist; very few medium faint brown mottles; medium clay; very few medium gravels, angular chert; weak 5-10mm polyhedral.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water pH	EC dS/m	Cl %	Particle Size CS	FS	Si	C % @ 105C	Exchangeable Cations* CEC	Ca	Mg	Na	K	Al	Acid meq per 100g soil	Moistures ADM	15mP % at 105C	Total Element P	K	S %
B.10	5.4	.09	.001										.20	.20					
0.10	5.5	.07	.000	20	35	22	23	5	2.1	2.6	.14	.28	.20	.20	1.3	8	.043	.135	.030
0.30	5.5	.02	.000	20	33	20	30	3	.41	1.8	.16	.10	.40	.60	0.9	9	.029	.175	.016
0.60	5.2	.02	.001	16	23	18	46	4	.20	3.0	.19	.07	.60	1.0	1.2	13	.034	.307	.017
0.90	5.3	.02	.001	11	21	17	53	5	.13	4.1	.25	.07	.60	.90	1.5	15	.043	.337	.016
1.20	5.5	.02	.001	13	21	16	54	5	.08	4.0	.23	.06	.40	.60	1.2		.046	.357	.016
1.50	5.4	.03	.002										.40	.60					

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Bicarb mg/kg	Rep K. meq %	DTPA extr. Fe	Mn	Cu	Zn ppm	SO4-S ppm
B.10	2.8	.16	8	14	.23	60	137	.87	.35	9

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Evander** SITE NO: **413**

SUBSTRATE MATERIAL: Alluvium SLOPE: 1.5%

AMG REFERENCE: 328 876 mE 7 341 811 mN ZONE 56

LANDFORM ELEMENT TYPE: Plain LANDFORM PATTERN TYPE: Alluvial plain

AUSTRALIAN CLASSIFICATION: Sodic, Eutrophic, Brown, Dermosol; medium, non gravelly, clayey, clayey, very deep

VEGETATION STRUCTURAL FORM: Tall isolated trees

DOMINANT SPECIES: *Eucalyptus moluccana, Eucalyptus tereticornis*

TYPE OF MICRORELIEF: Normal gilgai: Vertical Interval: 0.30 m Horizontal Interval: 10 m

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .07 m	Very dark greyish brown (10YR3/2) moist; silty light clay; massive, parting to weak 10-20mm angular blocky; moderately moist; moderately firm. Clear to-
A2j	.07 to .15 m	Greyish brown (10YR5/2) moist; silty light clay; massive; moderately moist; moderately firm; few medium manganiferous nodules. Clear to-
B21	.15 to .60 m	Brown (10YR5/3) moist; few medium distinct yellow mottles; medium clay; moderate 20-50mm angular blocky; dry; moderately strong. Gradual to-
B22	.60 to .90 m	Dark grey (10YR4/1) moist; medium clay; moderate 20-50mm angular blocky; dry; moderately strong. Diffuse to-
B23	.90 to 1.50 m	Very dark grey (10YR3/1) moist; heavy clay; moderate 20-50mm lenticular; dry; very firm.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC dS/m	Cl %	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
				% @ 105C				meq per 100g soil							% at 105C		%		
B.10	5.8	.11	.013																
0.10	5.9	.10	.013	1	12	37	48	16	6.5	8.1	.87	.71	.10	.10	3.1	16	.021	1.55	.017
0.30	5.7	.16	.023	1	8	35	59	20	8.1	10	1.6	.38	.30	.40	3.0	20	.013	1.48	.011
0.60	6.4	.39	.059	1	9	37	55	22	8.1	10	3.3	.24			2.2	18	.009	1.46	.008
0.90	7.6	.60	.080	1	8	37	54	26	9.8	11	5.3	.26			2.3	18	.009	1.54	.010
1.20	7.8	.90	.114	1	6	28	64	34	12	14	7.2	.32			3.3		.010	1.57	.009
1.50	7.9	.95	.120																

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			mg/kg			ppm				
B.10	2.9	.16	18	25	.50	166	76	2.1	2.7	16

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Harwood** SITE NO: **1109**

SUBSTRATE MATERIAL: Alluvium SLOPE: 1.5%

AMG REFERENCE: : 312932 mE 7350162 mN ZONE 56

LANDFORM ELEMENT TYPE: Levee LANDFORM PATTERN TYPE: Alluvial plain

AUSTRALIAN CLASSIFICATION: Bleached-sodic, Hypocalcic, Brown Chromosol; thin, non gravelly, loamy, clayey, very deep

VEGETATION STRUCTURAL FORM: Tall open woodland
DOMINANT SPECIES: *Eucalyptus crebra, Eucalyptus tereticornis*

SURFACE COARSE FRAGMENTS: No coarse fragments

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Dark greyish brown (10YR4/2) moist; fine sandy loam; massive; moderately moist moderately firm. Clear to-
A2e	.10 to .20 m	Greyish brown (10YR5/2) moist; fine sandy loam; massive; moderately moist very firm. Abrupt to-
B21	.20 to .50 m	Brown (10YR4/4) moist; few medium faint grey mottles ; sandy medium clay; moderate 20-50mm prismatic; moderately moist very firm. Gradual to-
B22k	.50 to 1.20 m	Dark brown (10YR3/3) moist; medium clay; strong 20-50mm angular blocky; few medium calcareous concretions; moderately moist very firm. Gradual to-
B23	1.20 to 1.55 m	Dark brown (10YR3/4) moist; common coarse distinct yellow mottles; medium clay; strong 10-20mm angular blocky; moderately moist very firm.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.2	.04	.005																
0.10	6.0	.03	.002	11	58	19	11	9	3.6	2.0	BQ	.40			1.4	6	.031	.811	.022
0.30	6.8	.04	.002	7	49	19	27	14	7.3	5.7	.65	.16			2.3	11	.020	.743	.016
0.60	8.1	.10	.009	4	37	22	38	20	13	9.4	1.5	.12			3.8	15	.020	.708	.018
0.90	8.4	.25	.025	5	32	23	41	22	16	11	2.2	.13			4.0	16	.025	.711	.017
1.20	8.5	.21	.023	5	41	19	35	18	13	9.5	2.0	.20			3.3		.025	.720	.014
1.50	8.4	.20	.025					18	12	8.5	1.8	.13							

Depth (m)	Org C W & B	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
	%	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
			mg/kg			ppm				
B.10	1.6	.10	37	25	.40	56	36	1.4	1.2	4.0

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Keppe**l SITE NO: **295**

SUBSTRATE MATERIAL: Sedimentary rocks SLOPE: 6.5%

AMG REFERENCE: 260 318 mE 7 441 971 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Undulating rises

AUSTRALIAN CLASSIFICATION: Magnesic, Mottled-Mesonatric, Brown, Sodosol; medium, moderately gravelly, clay loamy, clayey, moderate

VEGETATION: STRUCTURAL FORM: Tall woodland

DOMINANT SPECIES: *Eucalyptus moluccana, Eucalyptus crebra, Corymbia citriodora, Lophostemon confertus, Alphitonia excelsa*

SURFACE COARSE FRAGMENTS: Very few cobbles, angular chert

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .09 m	Dark greyish brown (10YR4/2) moist; sandy clay loam; many medium gravels, angular chert, very few large gravels, angular chert; massive; moist; moderately weak. Clear to-
A2e	.09 to .35 m	Greyish brown (10YR5/2) moist, light grey (10YR7/1) dry; sandy clay loam; many medium gravels, angular chert; massive; moist; moderately weak. Clear to-
B2	.35 to .60 m	Yellowish brown (10YR5/4) moist; common medium distinct grey mottles; medium clay; few large gravels, angular detrital sedimentary rock (unidentified); moderate 10-20mm angular blocky; moist; moderately firm. Gradual to-
B3	.60 to .90 m	Brown (10YR5/3) moist; common coarse distinct brown mottles; light medium clay; many large gravels, angular detrital sedimentary rock (unidentified); weak 20-50mm angular blocky; moist; moderately firm.

LABORATORY DATA:

Depth	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
(m)	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.2	.10	.003																
0.10	5.6	.04	.001	23	37	24	19	4	1.4	2.1	.23	.21			1.2	8	.019	.373	.020
0.30	5.9	.02	.002	19	29	29	24	3	.10	2.1	.30	.15			0.7	7	.010	.426	.008
0.50	6.0	.10	.010	26	18	16	41	17	.04	14	2.8	.16			2.7	19	.014	.464	.011
0.80	5.7	.28	.035	38	17	13	33	28	.02	19	9.1	.11			3.5	17	.018	.584	.023

Depth	Org C	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
(m)	W & B	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
	%		mg/kg			ppm				
B.10	3.5	.19	29	17	.25	120	26	2.7	1.5	33

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Kinka** SITE NO: **205**

SUBSTRATE MATERIAL: Sand SLOPE: 1%

AMG REFERENCE: 335 401 mE 7 349 038 mN ZONE 56

LANDFORM ELEMENT TYPE: Beach ridge LANDFORM PATTERN TYPE: Beach ridge plain

AUSTRALIAN CLASSIFICATION: Basic, Arenic, Rudosol; non gravelly, sandy, shallow over yellow brown sand

VEGETATION STRUCTURAL FORM: Tall woodland

DOMINANT SPECIES: *Corymbia tessellaris, Banksia integrifolia, Acacia aulacocarpa, Alphitonia excelsa*

SURFACE COARSE FRAGMENTS: No coarse fragments

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Loose

HORIZON	DEPTH	DESCRIPTION
A1	0 to .09 m	Dark greyish brown (10YR4/2) moist; fine sand; single grain; dry; loose. Clear to-
C1	.09 to .32 m	Dark yellowish brown (10YR4/4) moist; fine sand; single grain; dry; loose. Diffuse to-
C2	.32 to 1.20 m	Yellowish brown (10YR5/4) moist; fine sand; single grain; dry; loose.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	5.2	.03	.001																
0.10	5.3	.02	.001	34	62	3	2	1	.7	.4	.04	.07	.2	.2	0.3	1	.012	.244	.020
0.30	5.1	.01	.001	29	69	1	2	BQ	.1	.1	.01	.02	.3	.3	0.1	1	.009	.240	.008
0.60	5.6	.01	.000	25	73	2	1	BQ	.2	.1	.01	.02	.1	.1	0.2	1	.010	.272	.009
0.90	5.8	.01	.000	23	76	2	BQ	BQ	.1	.1	.01	.01	.1	.1	0.2	BQ	.009	.250	.007
1.20	5.9	.00	.000	23	76	3	BQ	BQ	.2	.1	.01	.01	BQ	BQ	0.1	BQ	.007	.233	.006

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			Mg/kg			ppm				
B.10	1.4	.06	5	2	.09	37	45	.40	.30	4

- Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Larcom** SITE NO**: 1112**

SUBSTRATE MATERIAL: Alluvium SLOPE: 0%

AMG REFERENCE: 311802 mE 7351603 mN ZONE 56

LANDFORM ELEMENT TYPE: Plain LANDFORM PATTERN TYPE: Alluvial plain

AUSTRALIAN CLASSIFICATION: Endohypersodic, Epipedal, Brown Vertosol, non gravelly, very fine, very fine, very deep

VEGETATION STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: *Eucalyptus moluccana, Eucalyptus tereticornis*

SURFACE COARSE FRAGMENTS: No coarse fragments

TYPE OF MICRORELIEF: Normal gilgai Vertical Interval 0.25 m Horizontal Interval 8 m Shelf sampled

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .12 m	Dark greyish brown (10YR4/2) moist; heavy clay; moderate 20-50mm angular blocky; moderately moist very firm. Clear to-
B21	.12 to .40 m	Olive brown (2.5Y4/3) moist; heavy clay; weak 50-100mm lenticular; very few medium manganiferous nodules; moderately moist very firm. Gradual to-
B22	.40 to .90m	Grey (5Y5/1) moist; common medium distinct brown mottles; heavy clay; moderate 50-100mm lenticular; very few medium manganiferous soft segregations; moderately moist very firm. Gradual to-
B23	.90 to 1.20 m	Olive black (5Y3/1) moist; heavy clay; strong 10-20mm lenticular; very few medium calcareous concretions; moist moderately firm. Gradual to-
B24	1.20 to 1.60 m	Dark olive (2.5Y3/3) moist; heavy clay; strong 10-20mm lenticular; very few medium manganiferous nodules; moist moderately firm.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*						Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.6	.04	.002																
0.10	6.7	.04	.002	2	10	23	65	38	11	17	1.4	.25			8.7	23	.029	.383	.027
0.30	6.6	.38	.050	1	7	23	69	40	13	20	3.5	.12			9.2	27	.021	.350	.022
0.60	6.7	.59	.094	1	15	35	53	30	8.6	15	4.0	.16			5.9	20	.011	.345	.014
0.90	7.4	.65	.104	1	13	33	54	33	9.4	17	4.9	.08			7.3	21	.012	.312	.015
1.20	8.2	.73	.115	1	13	30	58	36	11	20	6.9	.08			8.3		.017	.463	.014
1.50	8.3	.90	.139					39	11	22	6.4	.12							

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			mg/kg			ppm				
B.10	2.0	.14	12	11	.54	71	74	3.4	.89	9.0

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Lizard** SITE NO: **946**

SUBSTRATE MATERIAL: Sedimentary rocks SLOPE: 5.0%

AMG REFERENCE: 263286 mE 7449594 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Gently undulating rises

AUSTRALIAN CLASSIFICATION: Acidic, Mesotrophic, Red Ferrosol; thick, non gravelly, clayey, clayey, very deep

SURFACE COARSE FRAGMENTS: No coarse fragments

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
Ap	0 to .15 m	Dark reddish brown (2.5YR3/2) moist; light clay; moderate 2-5mm granular. Clear to-
A12	.15 to .35 m	Dark reddish brown (10R3/2) moist; light clay; weak 2-5mm granular; very few medium manganiferous soft segregations. Gradual to-
B21	.35 to .70 m	Dark red (10R3/4) moist; light clay; moderate 2-5mm polyhedral; very few medium manganiferous nodules. Diffuse to-
B22	.70 to 1.40 m	Dark red (10R3/4) moist; light clay; moderate 2-5mm polyhedral; very few medium manganiferous nodules. Diffuse to-
B23	1.40 to 1.60 m	Dark reddish brown (2.5YR3/4) moist; light clay; moderate 2-5mm polyhedral; very few medium manganiferous nodules.

LABORATORY DATA:

Depth	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
(m)	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	5.3	.30	.006																
0.10	5.3	.29	.007	11	25	19	45	8	4.1	2.1	.08	1.7			5.9	15	.109	.258	.058
0.30	5.1	.12	.002	9	25	19	47	6	3.5	1.7	.03	.34			6.5	17	.091	.157	.049
0.60	5.0	.06	.001	5	18	13	66	3	1.9	1.2	.06	.20			5.6	19	.054	.180	.050
0.90	5.0	.08	.001	4	16	13	70	4	2.3	1.9	.07	.14			6.3	20	.051	.190	.039
1.20	4.9	.08	.001	4	17	12	70	4	1.1	2.4	.04	.10			6.5	19	.053	.190	.032
1.50	4.9	.06	.001					3	.61	2.6	.06	.11				19			

Depth	Org C	Total N	Extr. Phosphorus		Rep K.		DTPA extr.				SO4-S
(m)	W & B	%	Acid	Bicarb	meq	%	Fe	Mn	Cu	Zn	ppm
	%		Mg/kg				ppm				
B.10	2.0	.15	44	25	1.4		16	269	3.6	2.2	138

- Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Meilland** SITE NO: **832**

SUBSTRATE MATERIAL: Granodiorite SLOPE: 4.0%

AMG REFERENCE: 303877 mE 7737019 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Gently undulating rises

AUSTRALIAN CLASSIFICATION: Basic, Paralithic, Orthic Tenosol; thick, non gravelly, sandy, clay loamy, moderate

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Soft

HORIZON	DEPTH	DESCRIPTION
Ap	0 to .18 m	Reddish brown (5YR4/3) moist; loamy coarse sand; massive; moist very weak. Gradual to-
A12	.18 to .32 m	Dark reddish brown (5YR3/3) moist; coarse sandy loam; massive; moist very weak. Gradual to-
B2	.32 to .70 m	Reddish brown (2.5YR4/6) moist; coarse sandy clay loam; very few medium gravels, rounded granitic; massive moist moderately weak. Gradual to-
C	.70 to 1.50 m	Reddish brown (2.5YR4/6) moist; coarse sandy clay loam; very few medium gravels, rounded granitic; massive; moist moderately weak. Gradual to-

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*						Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	7.0	.06	BQ					6	4.7	1.1	.03	.66							
0.10	7.1	.06	BQ	64	20	9	11	6	3.7	1.2	.07	.62			1.0	6	.046	5.44	.027
0.30	6.3	.02	BQ	56	24	7	14	3	1.5	.89	.03	.73			1.4	7	.046	5.30	.227
0.60	6.2	.03	BQ	51	26	10	14	4	2.9	1.0	.05	.19			1.1	7	.028	4.82	.015
0.90	6.0	.03	BQ	52	27	9	12	5	3.8	1.2	.10	.12			1.2	7	.023	4.75	.015
1.20	6.5	.02	BQ	55	29	7	11	4	3.0	1.0	.11	.10			1.0		.020	4.98	.012
1.50	6.7	.02	BQ					4	2.6	.77	.09	.10							

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			Mg/kg			ppm				
B.10	1.0	.08	98	59	.68	8.1	25	1.7	1.9	4.0

- Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Meilland** SITE NO: **1018**

SUBSTRATE MATERIAL: Granodiorite SLOPE: 2.5%

AMG REFERENCE: 306355 mE 7360740 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Gently undulating rises

AUSTRALIAN CLASSIFICATION: Basic, Paralithic, Orthic Tenosol; thick, non gravelly, loamy, loamy, very deep

SURFACE COARSE FRAGMENTS: Very few cobbles, angular granodorite

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A11	0 to .12 m	Dark reddish brown (5YR3/3) moist; coarse sandy loam; massive; moist very weak. Clear to-
A12	.12 to .32 m	Dark reddish brown (5YR3/3) moist; coarse sandy loam; massive moist very weak. Clear to-
B21	.32 to .70 m	Reddish brown (5YR4/6) moist; coarse sandy loam; massive moist moderately weak. Gradual to-
B22	.70 to 1.40 m	Reddish brown (5YR5/6) moist; coarse sandy loam; massive moderately moist moderately firm. Gradual to-
B3	1.40 to 1.55 m	Reddish brown (5YR5/6) moist; loamy coarse sand; massive moderately moist moderately weak.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.1	.05	.001																
0.10	6.3	.05	.001	57	23	8	12	7	4.2	1.7	.02	.77			1.4	7	.067	4.20	.023
0.30	6.0	.02	.001	58	22	8	13	5	3.1	1.1	.04	.35			1.1	7	.054	4.26	.016
0.60	6.1	.03	.001	61	19	9	12	5	3.6	1.3	.12	.22			1.2	7	.057	4.04	.013
0.90	6.2	.02	.001	55	23	12	12	5	3.0	1.8	.12	.17			1.3	7	.055	4.14	.009
1.20	6.4	.03	.001	58	20	12	12	4	2.4	1.6	.13	.17			1.3	7	.048	4.23	.008
1.50	6.4	.03	.001					5	2.9	2.0	.32	.17				7			

Depth (m)	Org C W & B	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
	%	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
			mg/kg			ppm				
B.10	1.1	.08	55	24	.61	19	31	.25	.87	3

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Muldoon** SITE NO: **822**

SUBSTRATE MATERIAL: Volcanic rocks SLOPE: 21%

AMG REFERENCE: 302248 mE 7371117 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Steep low hills

AUSTRALIAN CLASSIFICATION: Haplic, Eutrophic, Red Dermosol; thick, slightly gravelly, clayey, clayey, deep

SURFACE COARSE FRAGMENTS: Very few cobbles, angular

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A11	0 to .03 m	Reddish brown (5YR4/3) moist; light clay; common medium gravels angular; moderate 2-5mm granular; moist moderately weak. Sharp to-
A12	.03 to .30 m	Reddish brown (5YR4/3) moist; light clay; common medium gravels, angular; strong 5-10mm subangular blocky; moist moderately weak. Gradual to-
B2	.30 to .80 m	Reddish brown (2.5YR4/6) moist; medium clay; moderate 10 -20mm angular blocky; moist moderately firm. Gradual to-
B3	.80 to 1.10 m	Greyish brown (5YR5/2) moist; few coarse distinct grey mottles; medium heavy clay; common large gravels; weak 20-50mm lenticular; moderately moist very firm.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water pH	EC dS/m	Cl %	Particle Size CS	FS	Si	C % @ 105C	Exchangeable Cations* CEC	Ca	Mg	Na	K	Al	Acid meq per 100g soil	Moistures ADM	15mP % at 105C	Total Element P	K	S %
B.10	6.7	.06	BQ					17	13	3.1	.06	1.3							
0.10	6.8	.05	BQ	20	29	12	39	16	12	2.8	.05	1.4			2.7	15	.128	2.40	.059
0.30	6.9	.03	BQ	18	28	13	43	15	12	2.3	.07	.79			3.8	15	.102	2.44	.049
0.50	7.2	.02	BQ	15	24	14	49	16	13	2.9	.15	.22			3.0	15	.031	2.51	.020
0.60	7.2	.02	BQ	12	34	12	45	12	9.5	2.4	.11	.20			2.4	13	.026	2.55	.016
0.90	6.5	.02	BQ	12	32	11	47	14	9.8	3.4	.16	.19			2.0	13	.018	2.81	.014

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Bicarb Mg/kg	Rep K. meq %	DTPA extr. Fe	Mn	Cu	Zn ppm	SO4-S ppm
B.10	2.3	.26	117	59	1.3	18	120	2.8	11	5.0

- Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Pitt** SITE NO: **358**

SUBSTRATE MATERIAL: Alluvium SLOPE: 0.0%

AMG REFERENCE: 330 171 mE 7 348 750 mN ZONE 56

LANDFORM ELEMENT TYPE: Terrace LANDFORM PATTERN TYPE: Alluvial plain

AUSTRALIAN CLASSIFICATION: Supracalcic, Mottled-Hypernatric, Grey, Sodosol; medium, non gravelly, clay loamy, clayey, very deep

VEGETATION STRUCTURAL FORM: Mid-high isolated trees

DOMINANT SPECIES: *Eucalyptus tereticornis, Corymbia tessellaris*

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .07 m	Dark greyish brown (10YR4/2) moist; fine sandy clay loam; massive. Clear to-
A2e	.07 to .25 m	Light grey (10YR7/1) dry; fine sandy clay loam; massive. clear to-
B21	.25 to .50 m	Greyish brown (2.5Y4/2) moist; common coarse distinct yellow mottles; medium clay; strong 20-50mm prismatic. Gradual to-
B22	.50 to .80 m	Dark grey (10YR4/1) moist; heavy clay; weak 50-100mm lenticular. Gradual to-
B23	.80 to 1.20 m	Dark yellowish brown (10YR4/4) moist; heavy clay; moderate 20-50mm angular blocky; very few medium calcareous concretions. Gradual to-
B24k	1.20 to 1.60 m	Dark grey (10YR4/1) moist; heavy clay; strong 50-100mm lenticular; common coarse calcareous concretions.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	5.7	.18	.014																
0.10	5.9	.03	.003	4	59	21	17	6	2.8	2.3	.28	.17	.20	.30	0.9	7	.033	1.34	.018
0.40	7.1	.56	.078																
0.60	8.2	1.1	.145	2	23	21	58	24	6.2	11	7.8	.14			2.9	22	.016	1.46	.025
0.90	8.8	1.3	.167	1	21	19	59	28	6.9	12	10	.17			3.2	23	.016	1.50	.019
1.20	8.7	1.0	.104	1	20	21	61	28	6.7	12	11	.18			4.0		.015	1.56	.020
1.50	8.6	.88	.089																

Depth (m)	Org C W & B	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
	%	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
			mg/kg			ppm				
B.10	1.5	.10	25	31	.67	106	37	.83	1.7	16

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Raven** SITE NO: **616**

SUBSTRATE MATERIAL: Granodiorite SLOPE: 5.0%

AMG REFERENCE: 256 199 mE 7 470 905 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Hills

AUSTRALIAN CLASSIFICATION: Melanic, Paralithic, Chernic-Leptic, Tenosol; thick, non gravelly, loamy, shallow over weathered granodiorite

VEGETATION STRUCTURAL FORM:

DOMINANT SPECIES:

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Soft

HORIZON	DEPTH	DESCRIPTION
A11	0 to .10 m	Black (10YR2/1) moist; loam; strong 2-5mm granular; moderately moist; very weak. Clear to-
A12	.10 to .32 m	Black (10YR2/1) moist; loam; moderate 5-10mm subangular blocky; moderately moist; very weak. Gradual to-
A13	.32 to .50 m	Brown (10YR4/3) moist; coarse sandy loam; few medium gravels, subangular granodiorite; weak 5-10mm subangular blocky; moderately moist; very weak.
C	.50 to 1.50 m	Brownish yellow (10YR6/6) moist; loamy coarse sand; many medium gravels, subangular granodiorite; massive; moderately moist; moderately weak.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.9	.04	.002																
0.10	6.7	.03	.002	37	32	15	15	10	6.2	3.0	.18	.59			7.3	13	.117	2.70	.090
0.30	6.4	.01	.002	44	32	11	13	2	.80	.74	.12	.18			2.8	8	.025	3.00	.023
0.60	5.7	.01	.002	59	25	10	7	1	.49	.80	.12	.04			2.1	5	.016	2.71	.009
0.90	5.3	.01	.001	61	24	11	6	1	.52	.69	.14	.08			1.9	4	.014	2.57	.008
1.20	5.4	.01	.001	63	23	11	5	3	1.3	1.6	.16	.12			1.8	4	.012	2.65	.006
1.50	5.3	.01	.001																

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			mg/kg			ppm				
B.10	3.7	.29	42	58	.68	22	2.3	.06	2.3	6

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Rosslyn** SITE NO: **968**

SUBSTRATE MATERIAL: Sedimentary rocks SLOPE: 3.0%

AMG REFERENCE: 262533 mE 7447766 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Gently undulating rises

AUSTRALIAN CLASSIFICATION: Bleached-Sodic, Magnesic-Natric, Grey Kurosol; medium, moderately gravelly, clay loamy, clayey, moderate

VEGETATION STRUCTURAL FORM: Tall woodland

DOMINANT SPECIES: *Corymbia citriodora*

SURFACE COARSE FRAGMENTS: Common medium gravels, subangular chert

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .15 m	Dark greyish brown (10YR4/2) moist; fine sandy clay loam; many medium gravels, subangular chert; weak 5-10mm granular. Clear to-
A2e	.15 to .32 m	Light grey (10YR7/1) dry; sandy clay loam; many medium gravels, subangular chert; moist moderately weak. Abrupt to-
B2	.32 to .60 m	Grey (10YR5/1) moist; common medium distinct brown mottles; medium heavy clay; few medium gravels, angular sedimentary rock ; moderate 20-50mm angular blocky; moderately moist moderately strong. Gradual to-
B3	.60 to .75 m	Grey (10YR5/1) moist; common medium distinct red mottles; medium clay; few large gravels, angular sedimentary rock; weak 20-50mm angular blocky; moderately moist very firm.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	5.2	.06	.006																
0.10	4.8	.07	.006	29	35	15	20	3	1.4	1.0	.25	.40			3.4	9	.028	.442	.034
0.30	5.0	.03	.002	30	29	15	26	2	.36	1.3	.19	.19			2.4	9	.015	.522	.013
0.60	5.0	.08	.008	12	12	12	62	8	.13	6.9	1.1	.18			5.3	21	.007	.790	.013

Depth (m)	Org C W & B	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
	%	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
			Mg/kg			ppm				
B.10	2.8	.16	12	7	.35	103	20	.19	1.0	9

- Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Ruby** SITE NO: **250**

SUBSTRATE MATERIAL: Alluvium SLOPE: 0.5%

AMG REFERENCE: : 268 700 mE 7 444 300 mN ZONE 56

LANDFORM ELEMENT TYPE: Valley-flat LANDFORM PATTERN TYPE: Alluvial plain

AUSTRALIAN CLASSIFICATION: Haplic, Eutrophic, Brown, Kandosol; medium, moderately gravelly, clay loamy, clayey, moderate over gravelly alluvium

VEGETATION STRUCTURAL FORM: Mid-high tussock grassland

DOMINANT SPECIES: *Melinis repens*

SURFACE COARSE FRAGMENTS: Very few cobbles, angular chert

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A1	0 to .15 m	Dark greyish brown (10YR4/2) moist; clay loam; common large gravels, angular chert, very few cobbles, angular chert; moderate 2-5mm granular. Gradual to
B21	.15 to .40 m	Brown (7.5YR4/3) moist; light clay; few large gravels, angular chert; massive. Gradual to-
B22	.40 to .60 m	Brown (7.5YR4/4) moist; light clay; few large gravels, angular chert; massive; very few medium manganiferous nodules. Diffuse to-
C1	.60 to 1.10 m	Brown (7.5YR4/4) moist; light clay; abundant large gravels, angular chert, very few cobbles, angular chert; massive. Diffuse to-
C2	1.10 to 1.80 m	Strong brown (7.5YR4/6) moist; sandy clay loam; few large gravels, angular chert; massive; few medium manganiferous nodules.

LABORATORY DATA:

Depth	1:5 Soil/ Water			Particle Size				Exchangeable Cations							Moistures		Total Element		
(m)	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.1	.02	.000																
0.10	6.3	.03	.001	28	22	20	31	6	3.2	2.5	.15	.35			3.0	11	.052	.471	.029
0.30	6.4	.02	.000	26	25	20	33	6	3.0	2.2	.20	.15			1.6	10	.047	.480	.022
0.60	7.2	.03	.003	23	21	22	37	6	3.1	2.5	.33	.16			1.7	11	.049	.539	.015
0.90	7.2	.03	.002	30	21	18	33	5	2.4	2.2	.23	.19			1.7	10	.053	.573	.013
1.20	7.2	.02	.001	50	17	16	21	4	2.3	1.6	.24	.14			0.8		.046	.557	.009
1.50	6.5	.03	.002																

Depth	Org C	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
(m)	W & B	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	Ppm
	%		mg/kg			ppm				
B.10	1.3	.12	11	11	.35	44	166	3.0	3.3	6

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Selina** SITE NO: **435**

SUBSTRATE MATERIAL: Sand SLOPE: 1.0%

AMG REFERENCE: 273 391 mE 7 431 126 mN ZONE 56

LANDFORM ELEMENT TYPE: Swale LANDFORM PATTERN TYPE: Beach ridge plain

AUSTRALIAN CLASSIFICATION: Fragic, Sesquic, Aeric, Podosol; thick, non gravelly, sandy, sandy, moderate over shelly sands

VEGETATION STRUCTURAL FORM: Tall open forest

DOMINANT SPECIES: *Melaleuca dealbata, Banksia integrifolia*

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Loose

HORIZON	DEPTH	DESCRIPTION
A11	0 to .20 m	Brown (10YR5/3) moist; loamy fine sand; single grain; moist; very weak. Gradual to-
A12	.20 to .40 m	Greyish brown (10YR5/2) moist; loamy fine sand; single grain; moist; very weak. Gradual to-
A2e	.40 to .80 m	Light yellowish brown (10YR6/4) moist, very pale brown (10YR7/3) dry; fine sand; single grain; moist; loose. Gradual to-
B2	.80 to 1.00 m	Yellowish brown (10YR5/4) moist; sand; single grain; moist; loose. Gradual to-
C	1.00 to 1.60 m	Light yellowish brown (10YR6/4) moist, very pale brown (10YR7/4) dry; sand; single grain; moderately moist; loose; few fine shell fragments.

LABORATORY DATA:

Depth	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
(m)	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.4	.05	.011																
0.10	6.3	.03	.007	8	87	BQ	4	6	1.5	.81	.30	.10			0.4	2	.022	.680	.014
0.30	6.1	.02	.014	7	88	BQ	3	5	3.6	1.1	.20	.10			0.3	1	.013	.740	.010
0.60	7.0	.02	.004	5	91	2	2	3	1.4	.81	.31	.06			0.4	1	.009	.708	.007
0.90	7.7	.04	.007	5	91	2	2	3	2.9	.98	BQ	.04			0.4	1	.011	.804	.007
1.20	9.0	.11	.010	13	82	3	4								0.5	2	.023	.750	.026
1.50	9.0	.09	.016																

Depth	Org C	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
(m)	W & B	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
	%		mg/kg			ppm				
B.10	1.3	.05	18	37	.13	115	5.7	.07	.35	6

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Selina** SITE NO: **434**

SUBSTRATE MATERIAL: Sand SLOPE: 5.0%

AMG REFERENCE: 273 299 mE 7 431 137 mN ZONE 56

LANDFORM ELEMENT TYPE: Beach ridge LANDFORM PATTERN TYPE: Beach ridge plain

AUSTRALIAN CLASSIFICATION: Basic, Arenic, Orthic, Tenosol; medium, non gravelly, sandy, sandy, shallow over shelly sands

VEGETATION STRUCTURAL FORM: Tall open forest

DOMINANT SPECIES: *Banksia integrifolia, Alphitonia excelsa, Livistonia decipiens*

SURFACE COARSE FRAGMENTS: No coarse fragments

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Loose

HORIZON	DEPTH	DESCRIPTION
A1	0 to .15 m	Dark greyish brown (10YR4/2) moist; loamy fine sand; single grain; moist; very weak. Gradual to-
B2	.15 to .40 m	Yellowish brown (10YR5/4) moist; fine sand; single grain; moist; very weak. Gradual to-
C1	.40 to 2.80 m	Light yellowish brown (10YR6/4) moist; fine sand; single grain; moderately moist; loose; few fine shell fragments. Diffuse to-
C2	2.80 to 3.00 m	Light yellowish brown (10YR6/4) moist; sand; single grain; moderately moist; very weak; platy discontinuous thin ironpan; few fine shell fragments.

LABORATORY DATA:

Depth	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
(m)	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	7.2	.06	.007																
0.10	7.5	.05	.004	6	90	BQ	4	9	5.1	1.1	.20	.30			0.7	2	.049	.716	.025
0.30	7.2	.01	.007	6	93	BQ	2	4	1.3	.56	.20	.20			0.2	1	.038	.679	.009
0.60	8.7	.05	.005	7	92	BQ	2	3	2.0	.15	.30	.10			0.2	1	.035	.539	.012
0.90	9.1	.04	.003	12	87	BQ	1	2	1.5	.18	BQ	.04			0.2	BQ	.022	.411	.011
1.20	9.2	.05	.003	7	91	BQ	1								0.2	1	.022	.645	.013
1.50	9.2	.04	.003																

Depth	Org C	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
(m)	W & B	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
	%		mg/kg			ppm				
B.10	.96	.06	50	48	.35	19	7.7	.08	1.4	5

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Simpsons** SITE NO: **588**

SUBSTRATE MATERIAL: Alluvium SLOPE: 2.0%

AMG REFERENCE: 263 122 mE 7 469 369 mN ZONE 56

LANDFORM ELEMENT TYPE: Terrace LANDFORM PATTERN TYPE: Alluvial plain

AUSTRALIAN CLASSIFICATION: Bleached, Eutrophic, Brown, Chromosol; very thick, non gravelly, sandy, clayey, deep

VEGETATION STRUCTURAL FORM: Tall woodland

DOMINANT SPECIES: *Syncarpia glomulifera, Casuarina torulosa, Corymbia intermedia*

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Loose

HORIZON	DEPTH	DESCRIPTION
A1	0 to .15 m	Greyish brown (10YR5/2) moist; loamy fine sand; weak cast; moderately moist; moderately weak. Clear to-
A21	.15 to .60 m	Light yellowish brown (10YR6/4) moist; loamy fine sand; massive; moderately moist; moderately weak. Diffuse to-
A22	.60 to 1.15 m	Pale yellow (2.5Y7/5) moist; few medium faint grey mottles; loamy fine sand; massive; moderately moist; moderately weak. Clear to-
B2	1.15 to 1.40 m	Brown (7.5YR5/4) moist; few coarse distinct yellow mottles; sandy light clay; weak 5-10mm polyhedral; moderately moist; moderately firm. Clear to-
B3	1.40 to 1.50 m	Yellowish red (5YR5/6) moist; few coarse distinct brown mottles; fine sandy clay loam; massive; dry; very firm.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC dS/m	Cl %	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
				% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.3	.03	.003																
0.10	5.8	.04	.003	8	77	14	5	3	1.5	1.4	.20	.05			1.6	3	.008	.057	.019
0.30	6.1	.01	.001	6	79	9	8	1	.14	.53	.11	.01			0.4	2	.005	.042	.009
0.60	5.9	.02	.002	7	78	9	9	1	.10	.34	.14	.01			0.2	2	.004	.041	.007
0.90	6.0	.02	.003	6	79	12	5	1	.11	.47	.15	.01			0.2	2	.004	.039	.006
1.30	5.7	.03	.004	5	56	12	29	5	.94	3.4	.27	.04			4.2	10	.008	.171	.011
1.50	6.1	.02	.003																

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			mg/kg			ppm				
B.10	1.4	.06	BQ	3	.04	80	5.2	.02	.13	4

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Stevens** SITE NO: **1132**

SUBSTRATE MATERIAL: Volcanic rocks SLOPE: 18%

AMG REFERENCE: 263335 mE 7454464 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Undulating rises

AUSTRALIAN CLASSIFICATION: Humose, Dystrophic, Red Kurosol; medium, moderately gravelly, clay loamy, clayey, deep

VEGETATION: STRUCTURAL FORM: Tall open woodland
DOMINANT SPECIES: *Eucalyptus acmenoides, Corymbia intermedia, Casuarina torulosa*

SURFACE COARSE FRAGMENTS: Common large gravels, angular

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Soft

HORIZON	DEPTH	DESCRIPTION
A1	0 to .28 m	Black (7.5YR2/1) moist; clay loam; common large gravels; strong 2-5mm granular; moist very weak. Gradual to-
A2	.28 to .40 m	Brown (7.5YR4/3) moist; clay loam; common large gravels; moderate 5-10mm polyhedral; moist moderately weak. Clear to-
B2	.40 to .80 m	Red (2.5YR4/6) moist; medium heavy clay; strong 5-10mm polyhedral; moist moderately firm. Gradual to-
B3	.80 to 1.10 m	Red (2.5YR5/6) moist; common medium distinct yellow mottles; light clay; weak 5-10mm polyhedral; moist moderately weak. Gradual to-
C	1.10 to 1.35 m	Pinkish red (5YR7/4) moist; few coarse distinct brown mottles; fine sandy clay loam; moist moderately weak.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.4	.09	.007																
0.10	5.7	.10	.012	17	32	17	32	10	4.7	3.8	.52	.70	.70	.70	3.9	19	.073	1.44	.048
0.30	5.6	.03	.003	16	27	14	41	5	.57	1.2	.19	.27	2.5	2.6	3.4	20	.066	1.45	.037
0.60	5.1	.05	.006	2	14	18	69	7	.54	1.7	.22	.18	4.0	4.0	4.0	27	.049	1.35	.037
0.90	5.4	.04	.006	7	27	27	42	7	.45	2.3	.27	.14	4.3	4.5	3.7	20	.053	1.71	.030
1.20	5.7	.04	.005	16	41	29	17	5	.38	3.4	.34	.08	1.1	1.2	3.5		.048	2.06	.024

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			mg/kg			Ppm				
B.10	5.9	.29	13	11	.78	100	5.8	2.4	.72	9.0

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Swans** SITE NO: **831**

SUBSTRATE MATERIAL: Granodiorite SLOPE: 5%

AMG REFERENCE: 303510 mE 7370117 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Gently undulating rises

AUSTRALIAN CLASSIFICATION: Haplic, Eutrophic, Brown Chromosol; very thick, non gravelly, loamy, clayey, deep

SURFACE COARSE FRAGMENTS: No coarse fragments

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
Ap	0 to .15 m	Greyish brown (7.5YR4/2) moist; coarse sandy loam; massive; moist very weak. Gradual to-
A12	.15 to .70 m	Brownish black (7.5YR3/2) moist; coarse sandy clay loam; very few medium manganiferous soft segregations; massive; moist moderately weak. Diffuse to-
A2	.70 to .80 m	Greyish brown (7.5YR5/2) moist; coarse sandy clay loam; very few medium manganiferous soft segregations; massive; moist moderately weak. Clear to-
B22	.80 to 1.40 m	Brown (7.5YR4/4) moist; common medium faint yellow mottles; sandy light medium clay; few large angular gravels; moderate 20-50mm angular blocky; moist moderately firm.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations							Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.2	.03	BQ					11	7.8	2.2	.06	.64							
0.10	6.3	.03	BQ	66	16	2	17	7	5.3	1.5	.04	.52			2.1	7	.202	3.24	.059
0.30	6.0	.02	BQ	55	22	6	18	9	5.9	2.2	.05	.46			2.0	8	.181	3.10	.047
0.60	6.4	.03	BQ	47	24	11	19	13	9.2	3.5	.18	.16			2.8	10	.108	2.89	.040
0.90	6.8	.06	BQ	37	21	13	32	18	9.8	7.5	.49	.16			4.3	14	.080	2.13	.017
1.20	6.8	.10	BQ	28	26	16	32	22	12	9.5	.67	.16			5.2		.080	1.91	.028

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			Mg/kg			ppm				
B.10	1.6	.13	644	336	.63	186	22	59	5.2	5.0

- Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Tanby** SITE NO: **455**

SUBSTRATE MATERIAL: Sedimentary rocks SLOPE: 2.0%

AMG REFERENCE: 266 298 mE 7 437 339 mN ZONE 56

LANDFORM ELEMENT TYPE: Hillslope LANDFORM PATTERN TYPE: Rises

AUSTRALIAN CLASSIFICATION: Bleached, Magnesic, Grey, Kurosol; thick, moderately gravelly, loamy, clayey, deep

VEGETATION STRUCTURAL FORM:

DOMINANT SPECIES:

SURFACE COARSE FRAGMENTS: Few large gravels, subrounded ironstone

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
Ap	0 to .30 m	Dark greyish brown (10YR4/2) moist; sandy loam; many medium gravels, rounded ironstone; massive. Clear to-
A2e	.30 to .42 m	White (10YR8/2) dry; sandy clay loam; many medium gravels, rounded ironstone; massive. Clear to-
B2	.42 to .90 m	Grey (10YR5/1) moist; common coarse distinct red mottles; medium heavy clay; few large gravels, angular sandstone; weak 20-50mm angular blocky. Gradual to-
B3	.90 to 1.10 m	Grey (10YR5/1) moist; few coarse distinct brown mottles; medium heavy clay; common large gravels, angular sandstone; weak 10-20mm angular blocky.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC dS/m	Cl %	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
				% @ 105C				meq per 100g soil							% at 105C		%		
B.10	5.1	.16	.003																
0.10	5.1	.05	.002	19	54	12	16	25	3.6	12	8.8	.27			0.7	4	.025	.454	.018
0.30	5.3	.02	.001	21	53	11	17	2	.67	.61	.12	.16			1.2	5	.022	.490	.018
0.60	5.4	.04	.002	10	10	11	71	12	.21	4.7	.48	.15	5.0	6.0	8.7	21	.010	1.87	.020
0.90	5.6	.04	.002	12	8	20	62	14	.07	5.3	1.0	.09	6.3	8.2	5.7	20	.007	2.25	.015

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			mg/kg			ppm				
B.10	1.0	.03	45	37	.24	60	2.2	.25	.77	88

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Tilden** SITE NO: **451**

SUBSTRATE MATERIAL: Estuarine clay SLOPE: 0.0%

AMG REFERENCE: 272 700 mE 7 435 800 mN ZONE 56

LANDFORM ELEMENT TYPE: Supratidal flat LANDFORM PATTERN TYPE: Tidal flat

AUSTRALIAN CLASSIFICATION: Sulfidic, Supratidal, Hydrosol; thin, non gravelly, clayey, over estuarine sediments

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A1	0 to .05 m	Dark brown (10YR3/3) moist; light clay; moderate 5-10mm platy; moderately moist; moderately firm. Sharp to-
	.05 to .20 m	Brown (10YR4/3) moist; common medium distinct yellow mottles; light clay; massive; moist; moderately weak. Gradual to-
	.20 to .50 m	Dark grey (10YR4/1) moist; few medium distinct yellow mottles; light clay; massive; moist; moderately weak. Clear to-
	.50 to .70 m	Very dark grey (10YR3/1) moist; light clay; massive; wet;. Clear to-
	.70 to 1.40 m	Grey (5Y6/1) moist; common medium distinct yellow mottles; sandy medium clay; massive; wet.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	mg/kg	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	4.4	7.47	13500																
0.05	4.2	9.02	25000						1.3	18	39	1.8	1.0	1.4	5.0	19	.069	1.61	.487
0.20	3.8	12.08	12000																
0.40	3.6	20.6	22500	1	7	21	68		2.7	26	98	1.8	1.4	2.2	3.4	24	.036	1.85	1.38
0.60	3.5	17.1	22800	10	17	20	53		2.2	23	80	1.5			3.1	IS	.032	1.67	1.44

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Extr. Phosphorus Bicarb	Rep K. meq %	DTPA extr. Fe	DTPA extr. Mn	DTPA extr. Cu	DTPA extr. Zn	SO4-S ppm
			mg/kg			ppm				
B.10	1.0	.07	25	35	1.8	86	16	1.1	4.0	2000

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

Depth	Actual Acidity	Potential Acidity
0.2-0.3m	47	95 mol (+/t) @ 85^0C
0.6-0.7m	49	1674 mol (+/t) @ 85^0C
0.7-0.8m	55	1178 mol (+/t) @ 85^0C

SOIL NAME: **Tilden** SITE NO: **567**

SUBSTRATE MATERIAL: Estuarine clay SLOPE: 0.0%

AMG REFERENCE: 270 400 mE 7 431 846 mN ZONE 56

LANDFORM ELEMENT TYPE: Supratidal flat LANDFORM PATTERN TYPE: Tidal flat

AUSTRALIAN CLASSIFICATION: Sulfidic, Supratidal, Hydrosol; thin, non gravelly, clayey, over estuarine sediments

VEGETATION STRUCTURAL FORM:

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Brown (10YR4/3) moist; light clay. Clear to-
	.10 to .20 m	Red (10R4/6) moist; common coarse distinct yellow mottles; light clay. Clear to-
	.20 to .60 m	Very dark grey (5Y3/1); light clay; wet; decomposed plant material. Gradual to-
	.60 to .80 m	Dark grey (5Y4/1); light clay; wet.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water pH	EC dS/m	Cl mg/kg	Total Acidity Actual mol (+/t) @ 85°C	Potential	Exchangeable Cations* CEC	Ca	Mg	Na	K	Al	Acid	Moistures ADM 15m % at 105C	Total Element P	K	S
						meq per 100g soil								%		
0 - 0.3	4.4	27.2	50870	1.3	3.3	3.0	35	140	2.3	.30	.30		.049	1.47	.674
0.1 - 0.2	4.0	32.0	62390	2.5	.70	2.1	40	147	2.2	.30	.40		.091	2.07	2.20
0.3 - 0.6	3.7	56.0	99999	22.5	1458	4.9	56	304	3.4	.40	1.9		.018	1.09	1.97
0.6 - 0.8	3.7	60.1	99999	35.9	1663	4.7	58	300	3.5	.50	2.2		.019	1.10	1.98

Depth (m)	Org C W & B %	Total N %	Extr. Phosphorus Acid	Bicarb mg/kg	Rep K. meq %	DTPA extr. Fe	Mn	Cu	Zn mg/kg	SO4-S ppm
0 - 0.3				28			13	.75	1.9	3010
0.1 - 0.2				17			11	.54	1.6	3650
0.3 - 0.6				13			15	.26	1.2	4960
0.6 - 0.8				14			16	.03	6.4	5400

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Valetta** SITE NO: **615**

SUBSTRATE MATERIAL: Alluvium SLOPE: 3.0%

AMG REFERENCE: 264 083 mE 7 468 739 mN ZONE 56

LANDFORM ELEMENT TYPE: Terrace LANDFORM PATTERN TYPE: Alluvial plain

AUSTRALIAN CLASSIFICATION: Acidic, Regolithic, Orthic, Tenosol; medium, non gravelly, loamy, loamy, moderate

VEGETATION STRUCTURAL FORM:

DOMINANT SPECIES:

SURFACE COARSE FRAGMENTS: No coarse fragments

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A11	0 to .10 m	Dark greyish brown (10YR4/2) moist; fine sandy loam; weak cast; moderately moist; moderately weak. Clear to-
A12	.10 to .30 m	Dark greyish brown (10YR4/2) moist; fine sandy loam; massive; moderately moist; moderately weak. Gradual to-
B2	.30 to .60 m	Brown (10YR4/3) moist; fine sandy loam; massive; moderately moist; moderately weak. Gradual to-
C1	.60 to 1.00 m	Brown (7.5YR4/4) moist; sandy loam; massive; moist; very weak. Diffuse to-
C2	1.00 to 1.55 m	Brown (7.5YR4/3) moist; sandy loam; massive; moist; very weak.

LABORATORY DATA:

Depth	1:5 Soil/ Water			Particle Size				Exchangeable Cations*							Moistures		Total Element		
(m)	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.1	.02	.002																
0.10	5.9	.02	.001	11	66	8	15	2	.93	.95	.10	.35			1.4	5	.046	1.66	.022
0.30	5.4	.02	.001	10	68	9	15	1	.36	.48	.11	.12			1.9	5	.022	1.59	.015
0.60	5.4	.01	.001	11	69	9	12	1	.23	.44	.11	.14			1.3	4	.015	1.69	.012
0.90	5.6	.01	.001	14	67	9	12	2	.70	.71	.12	.14			1.5	4	.012	1.77	.009
1.20	5.8	.02	.001	17	63	5	14	3	1.4	.78	.14	.20			2.0	5	.014	1.89	.010
1.50	5.8	.02	.001																

Depth	Org C	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
(m)	W & B	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
	%		mg/kg			ppm				
B.10	1.1	.08	16	12	.23	57	24	5.1	1.4	6

* Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method

SOIL NAME: **Yaringa** SITE NO: **128**

SUBSTRATE MATERIAL: Alluvium SLOPE: 0.0%

AMG REFERENCE: 316 586 mE 7 354 976 mN ZONE 56

LANDFORM ELEMENT TYPE: Plain LANDFORM PATTERN TYPE: Alluvial plain

AUSTRALIAN CLASSIFICATION: Hypocalcic, Mottled-Subnatric, Brown, Sodosol; thin, non gravelly, silty, clayey, very deep

VEGETATION STRUCTURAL FORM: Tall woodland

DOMINANT SPECIES: *Eucalyptus tereticornis, Lophostemon suaveolens, Melaleuca nervosa, Heteropogon contortus, Imperata cylindrica*

SURFACE COARSE FRAGMENTS: No coarse fragments

TYPE OF MICRORELIEF: Normal gilgai Vertical Interval 0.15 m Horizontal Interval 18 m Shelf sampled

PROFILE MORPHOLOGY:

CONDITION OF SURFACE WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .05 m	Greyish brown (2.5Y5/2) moist; silty clay loam; massive; dry; very firm. Sharp to-
A2e	.05 to .10 m	White (10YR8/1) dry; few medium distinct yellow mottles; silty clay loam; massive; dry; very firm; very few medium manganiferous nodules. Abrupt to-
B21	.10 to .40 m	Greyish brown (2.5Y5/3) moist; common medium distinct grey mottles; medium clay; moderate 50-100mm angular blocky; dry; moderately strong; very few medium manganiferous nodules. Gradual to-
B22	.40 to .75 m	Greyish brown (2.5Y5/2) moist; few medium distinct grey mottles; medium heavy clay; very few medium gravels, rounded; moderate 50-100mm lenticular, parting to moderate 20-50mm angular Blocky; moist; moderately firm; very few medium manganiferous nodules. Gradual to-
B23	.75 to 1.20 m	Dark grey (5Y4/1) moist; medium heavy clay; very few medium gravels, rounded; moderate 20-50mm lenticular; moist; moderately firm; very few medium manganiferous nodules, very few medium Calcareous nodules. Gradual to-
B24	1.20 to 1.55 m	Grey (5Y5/1) moist; medium heavy clay; very few medium gravels, rounded; moderate 50-100mm lenticular; moist; moderately firm; few medium manganiferous nodules, very few medium calcareous nodules.

LABORATORY DATA:

Depth (m)	1:5 Soil/ Water			Particle Size				Exchangeable Cations							Moistures		Total Element		
	pH	EC	Cl	CS	FS	Si	C	CEC	Ca	Mg	Na	K	Al	Acid	ADM	15mP	P	K	S
		dS/m	%	% @ 105C				meq per 100g soil							% at 105C		%		
B.10	6.1	.04	.003																
0.10	5.9	.05	.004	1	33	46	26	7	3.2	3.4	.49	.19	.10	.10	1.2	11	.020	.394	.033
0.30	6.2	.15	.015	3	13	18	67	26	10	13	2.3	.19	.10	.10	4.1	23	.021	.467	.037
0.60	6.9	.43	.055	3	17	23	58	27	10	13	4.3	.14			3.9	21	.020	.468	.034
0.90	7.8	.70	.085	2	15	26	57	35	11	15	5.2	.10			4.2	21	.018	.477	.031
1.20	8.3	.85	.102	1	18	25	53	38	12	17	6.1	.11			5.3		.018	.484	.029
1.50	8.2	.89	.109																

Depth (m)	Org C W & B	Total N	Extr. Phosphorus		Rep K.	DTPA extr.				SO4-S
	%	%	Acid	Bicarb	meq %	Fe	Mn	Cu	Zn	ppm
			Mg/kg			ppm				
B.10	1.3	.07		5	.22	83	50	2.2	.67	

- Cations for soils with pH less than 7.0 are determined by the Aqueous Method and with pH above 7.0 are determined by the Alcoholic Method