Land systems of the Nebo area, Central Queensland

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Summary

This report presents the results of a land system survey of an area of land around Nebo in Central Queensland. The land system survey has been undertaken as part of a broader land and irrigation assessment study of Nebo and Broadsound Shires.

Detailed soil surveys have been completed for the intensively cropped parts of the Central Queensland coast with broad scale land system surveys conducted over almost all of the remaining area. However, an area around Nebo township has never been covered by either land system or soil surveys. This infill survey area comprises 434, 330 ha in two separate southern and northern sections north and south of Nebo.

Land systems were identified and delineated using available land resource information and reconnaissance fieldwork that involved collecting land resource data at 126 sites. These field sites were not located evenly across the survey area but were concentrated so that approximately 80% were located within landscapes with some potential for agricultural development. The remaining 20% were located in strongly undulating to hilly terrain with little potential for development. Fieldwork was concentrated in the southern section of the infill area.

Twenty-six land systems have been delineated within the infill area. Their distribution is shown on the accompanying map and a key is provided to identify the land systems. Twenty of these land systems were previously identified in adjacent surveys and have been extended into the infill area. Six new land systems have been identified during this survey and are described in this report.

Low hills and rises with eucalypt woodlands are the dominant landscape feature, covering more than 30% of the infill area. The eucalypt woodlands include swamp mahogany as a major species in the wetter southeast portion. The low hills and rises often merge with less dissected rises and plains containing eucalypt woodlands that cover almost 18% of the area.

Mountains with eucalypt woodlands cover almost 25% of the area and mountainous terrain with softwood scrub, vine forest and acacia scrub account for almost 14%. Smaller areas of hills with eucalypt woodlands (almost 7%) and alluvial plains with eucalypt woodlands (4%) are also included. Hills, rises and plains with vegetation other than eucalypts represent the remaining 3% of the area.

The component land units have been differentiated mainly on the basis of topography and soils. Remnant native vegetation mapping by the Queensland Herbarium has been used to compile a summary description of the vegetation for each unit.

1. Introduction

1.1 Purpose of survey

This report presents the results of a land system survey of an area of land around Nebo in Central Queensland.

The land system survey has been undertaken as part of a broader land and irrigation assessment study of Nebo and Broadsound Shires. The study was jointly funded by both shire councils, the Queensland Departments of Natural Resources and Mines (QNRM) and State Development and the Mackay Sugar Cooperative.

Detailed soil surveys have been completed for the intensively cropped parts of the Central Queensland coast with broad scale land system surveys conducted over almost all of the remaining area. However, an area of land north and south of Nebo has never been covered by either land system or soil surveys.

The purpose of this survey was to compile a broad scale land systems coverage of the unmapped area to enable a feasibility assessment of potential irrigation development to be conducted over both shires.

1.2 Description of survey area

The infill survey area consists of two separate southern and northern sections as shown in Figure 1. The eastern boundary for the southern section extends along the coastal ranges from 22 ºS to Mackay and then follows the Nebo Shire boundary north of Mackay. CSIRO land systems mapping for the Isaac-Comet area (Story et al. 1967) forms the western boundary south to 22 ºS. Land systems mapping of the Capricorn coast by QNRM (Forster and Barton 1995) forms the southern boundary at this latitude.

The Nebo Shire boundary forms the eastern and northern boundary for the northern section of the infill area. The western boundary is along the edge of the CSIRO land system mapping of the Nogoa-Belyando catchment (Gunn et al. 1967) and land system mapping of the Isaac-Comet area (Story et al. 1967) forms the southern boundary.

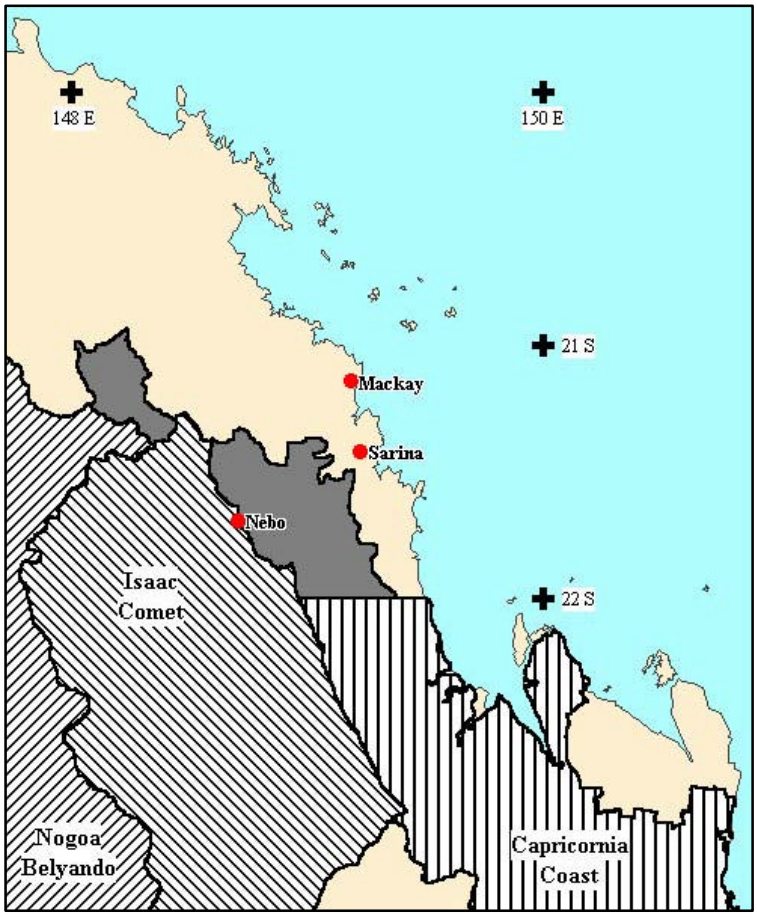


Figure 1. Location diagram

2. Methodology

2.1 Collating available data

A land system represents a distinctive pattern of geology, topography soils and vegetation. Existing published and unpublished data describing these land resources was collected from numerous sources.

Mapping for the national 1:250,000 geological series as collated in the publication titled Queensland geology (Day et al. 1983) was used as the geological base for the northern section. Remapping of the South Connors-Auburn-Gogango area by geological survey staff (Hutton et al. 1999) was used as the geological base for the southern section.

Topographic information was taken from 1:100,000 topographic maps with a contour elevation of 40 m.

Some soils data was available for the area as site information collected by the Queensland Department of Primary Industries (Shields 1984) and QNRM (Jon Burgess, unpublished data). Twenty-four sites with full soil and landscape descriptions were extracted from the QNRM soil database. These sites were either within the survey area or close to the survey area and representing landscapes that extend into the survey area.

Vegetation data was collated from several sources including remnant vegetation mapping for the state by the Queensland Herbarium, land systems of the Capricornia coast (Forster and Barton 1995) and vegetation mapping of the Burdekin-Townsville region (Isbell and Murtha 1972).

2.2 Collecting land resource information

Land resource information was collected during fieldwork at a further 102 sites. Sites were located along major roads and tracks. The total 126 sites were not located evenly across the survey area but were concentrated so that approximately 80% were located within landscapes with some potential for agricultural development. The remaining 20% were located in strongly undulating to hilly terrain with little potential for development.

Fieldwork was concentrated in the southern section of the infill area. Broad scale land capability mapping has been done at a nominal scale of 1:250,000 for the Bowen-Broken Rivers region (Venz et al. 1973), which includes the northern section of the infill area. Mapping units on the land capability map are delineated on the basis of topography, dominant soils and vegetation. Hence, this mapping provided a working basis for delineating land systems in the northern section. Field investigations in the northern section were aimed at verifying land resource descriptions and matching land system names from the adjacent Nogoa-Belyando catchment (Gunn et al. 1967) to the mapping units on the land capability map.

The location of each site was recorded using a hand-held GPS receiver with an accuracy varying from ± 3 to 10 m. All land resource information was described using standard terminology of the Australian soil and land survey handbook (McDonald et al. 1990).

2.3 Mapping land systems

The site data and general field observations formed the basis for identifying and delineating land systems.

Land systems were extended from the adjacent survey areas into the southern section where applicable but 6 new land systems had to be described, especially in the wetter, eastern part of the southern section.

Land system names used for the adjacent Nogoa-Belyando catchment were matched with mapping unit descriptions from the land capability map covering the northern section of the infill area. Mapping unit boundaries on the land capability map were adjusted where necessary to fit within the land system descriptions.

There are several instances of different names being given to essentially the same land system where mapped separately in the adjacent survey areas. Where these overlapping land systems extend into the infill area a combined name such as Connors/Alpha has generally been adopted.

However, Nebo land system from the Isaac-Comet area contains a wide range of landscape features. Parts of the Nebo landscape have been mapped separately on the Capricornia coast as a new land system named Macksford. This split has been followed for the infill area with Macksford being retained for land that is similar to that described as Macksford on the Capricornia coast. The remaining Nebo landscape features have been described and mapped as Nebo land system within the infill area.

2.4 Describing component land units

The component land units have been differentiated mainly on the basis of topography and soils. Remnant native vegetation mapping by the Queensland Herbarium has been used to compile a summary description of the vegetation for each unit. This description has been modified where necessary to reflect major species differences as observed during field investigations.

As each land unit was differentiated it was numbered sequentially from 1 onwards. Thus, land unit 3 in this report may occur within two or more land systems. This numbering system has been used for both CSIRO and DPI land system reporting since 1974. However, the earlier Isaac-Comet and Nogoa-Belyando land system reports number where the land units form 1 onwards within each land system.”

3. General description of land resources

3.1 Geology

The southern section of the infill area lies mainly within an arc of uplands referred to as Connors Arch. These uplands extend into the northern section of the infill area, along its eastern margins. Connors Arch was formed by extrusions from a series of volcanoes originally located on the continental side of an oceanic trench. This volcanic arc has been extensively intruded by granitic rocks.

On the western side of Connors Arch is the Bowen Basin, a broad depression formed by continental and marine deposition. Most of the infill area's northern section lies within this basin, as do the western margins of the southern section.

Whereas Connors Arch is characterised by strongly dissected hilly and mountainous terrain, the Bowen basin consists of gently undulating to undulating plains and rises interspersed with occasional mountainous terrain and tablelands.

The oldest rocks in the area are within Connors Arch and consist of acid to intermediate volcanics and pyroclastic flows with conglomerate at their base. This sequence has been mapped as part of the Connors Volcanics geological unit (Hutton et al. 1999). Granites of the Urannah Complex have intruded the Connors Volcanics. The Urannah Complex consists of adamellite, granodiorite, hornblende diorite and quartz diorite, biotite granite, hornblende gabbro, hornblendite and microdiorite (Day et al. 1983).

Both the granites and Connors Volcanics have been dated as part of the early Carboniferous period at approximately 300 million years old.

Along the eastern flank of the Connors Volcanics and granites are early Permian volcanic and sedimentary rocks of the Carmila Beds. The Carmila Beds consist of acid to intermediate pyroclastic flows, volcanic rudite, altered basalt, conglomerate, sandstone, siltstone and shale. Similar rocks form the Lizzie Creek Volcanics along the western flank. Both geological units were formed during the early Permian, approximately 290 million years ago.

Further west, a series of sedimentary rocks were deposited in the Bowen Basin during the middle Permian, approximately 250 years ago. The sedimentary sequence includes lithic labile sandstone, conglomerate, siltstone, shale, mudstone, coal and cherty tuff.

The rocks were later deformed and folded along the eastern margins of the basin. Subsequent erosion and deposition resulted in a new series of sedimentary rocks being deposited during the late Permian and Triassic periods, approximately 245 to 210 million years ago. Characteristic rocks in this later sequence include red-brown mudstone, lithic labile sandstone, siltstone and conglomerate. They are more resistant to weathering and now form the mountainous and hilly terrain of the Redcliffe Tableland in the northwest of the infill area.

A series of isolated granitic intrusions resulting in similar rocks as in the Urannah Complex occurred along the eastern flank of Connors Arch during the Cretaceous period, approximately 135 to 65 million years ago (Hutton et al. 1999).
Renewed volcanic activity during the Tertiary period approximately 15 to 55 million years ago resulted in minor flows of basalt and similar rocks along the western side of Connors

Arch and eastern margins of the Bowen Basin. Most of these flows now form mountains and hills within the infill area though gently undulating rises do occur west of Nebo.

Deep weathering, erosion and deposition over a similar period resulted in unconsolidated sediments being deposited along the western margins of the southern section as well as consolidated deposits of quartzose sandstone, clayey sandstone, siltstone and minor conglomerate being formed in the northern section.

Recent erosion and deposition has resulted in the limited formation of unconsolidated alluvium (sand, soil, gravel) along the major streams. Within the infill area, the recent alluvium is greatest along the lower reaches of Denison Creek and Funnel Creek.

3.2 Landform

Characteristic relief and modal slope classes for the landform patterns (McDonald et al. 1990) within the infill area are given in Table 2.

The landscape is strongly dissected with mountains, hills, low hills and undulating rises occurring on almost 90% of the infill area.

Mountains are the dominant landform pattern occupying 38.5% of the area. Mountainous terrain dominates the southern section of the infill area and forms two broad bands along the northwestern and northeastern margins of the northern section. The relief/modal slope classes for most mountainous areas are steep to very steep mountains but gentler rolling terrain also occurs.

Hills occur on a further 7%. The hilly terrain is scattered throughout the infill area, generally associated with the mountains. Slopes are generally gentler than on the mountainous terrain with most areas classified as rolling to steep hills though undulating hills with gentler slopes also occur.

Low hills and rises occupy 30.2 % of the infill area. The largest areas occur in the southern section between the coastal ranges and Nebo. The low hills and rises are predominantly undulating but rolling to steep areas also occur.

Table 1. Landform patterns and relief/modal slope classes

Landform pattern	Relief/modal slope class	Area	
		(ha)	(%)
Mountains	Steep to very steep mountains	137,940	31.8
	Rolling to steep mountains	28,940	6.7
Hills	Steep to very steep hills	8,630	2.0
	Rolling to steep hills	19,910	4.6
	Undulating hills	1,980	0.4
Low hills and rises	Rolling to steep low hills	4,260	1.0
	Undulating low hills and rises	126,930	29.2
Rises and plains	Undulating rises	57,320	13.2
	Gently undulating to undulating rises	17,720	4.1
	Gently undulating to level plains	12,680	2.9
Alluvial plains	Level to gently undulating plains	18,020	4.1

Landform pattern	Relief/modal slope class	Area	
		(ha)	(%)
Total		**434,330**	**100.0**

Notes:

Landform patterns and relief/modal slope classes are from McDonald et al. (1990).

Less dissected rises and plains cover 20.2 % of the infill area. The rises and plains are mainly gently undulating to undulating.

Level to gently undulating alluvial plains account for only 4.1% of the infill area.

3.3 Soils

The range of soils observed within the infill area has been grouped according to their profile features, parent material and inferred geomorphic history. Geomorphic history has been extrapolated from numerous soil surveys undertaken by the author elsewhere in Central Queensland. These previous investigations have shown that soil physical and chemical attributes are closely associated with such attributes.

A brief description of each soil group including its distinguishing characteristics is given in Table 2.

Red, yellow and brown podzolics occur on mountainous and hilly terrain under vine forest and eucalypt woodlands. They have a sandy or loamy surface layer grading into a pale or bleached subsurface that abruptly overlies red, yellow or brown clay subsoil. Structure is moderate to strong and fine in the subsoil but varies in the surface and subsurface from massive under eucalypt vegetation to moderate under vine forest. The soils have an acid pH throughout the profile and are non-sodic. On granitic rocks textures range from loamy sand to sandy clay loam in the surface and subsurface to sandy light clay and sandy medium clay in the subsoil. On acid to intermediate volcanics, pyroclastics and sedimentary rocks, surface and subsurface textures tend to be sandy clay loam, loam or clay loam and sand is not evident in the light clay to medium heavy clay subsoil.

Bleached sands and sandy loams occur on mountainous and hilly terrain under eucalypt woodlands and acacia scrub and under eucalypt woodlands on upper slopes and crests of granitic low hills and rises. They have a grey or brown sand to sandy loam surface grading into a bleached subsurface of similar texture that directly overlies rock or gravel. Structure varies from massive to weak. Soil depth is generally less than 50 cm on acid to intermediate volcanics, pyroclastics and sedimentary rocks but may be much deeper, grading through weathered rock into hard bedrock on granitic terrain.

Shallow stony sandy loams and loams are found under vine forest, softwood scrub and eucalypt woodlands on mountains and hills and also occur frequently under eucalypt woodlands throughout the low hills and rises on acid to intermediate volcanics, pyroclastics and sedimentary rocks. These soils are mainly grey or brown with textures ranging from sandy loam to clay loam. Stone and gravel are abundant and the soils overlie rock or gravel by 50 cm. Structure varies from massive to weak.

Shallow stony clay loams and clays occur on mountains, hills low hills and rises overlying basalt, intermediate to basic volcanics and pyroclastic rocks. Vegetation can be either

softwood scrub or eucalypt woodlands. The soils have brown to black clay loams to light medium clays that overlie rock or gravel by 50 cm depth. Structure varies from massive in the lighter textured profiles to moderate in the clays. Stone and gravel are abundant.

Gravelly black loams and clay loams are restricted to the footslopes and local alluvial flats of mountainous and hilly terrain with vine forest. Textures vary from sandy loam to clay loam and structure varies from massive in the sandier profiles to moderate in the clay loams. The soils overlie other buried soil material and gravel beds at variable depth.

Red and brown earthy sands occur on granitic mountains, hills and low hills. The soils have massive sands and sandy loams that are acid and non-sodic. Profile depth can vary from moderately deep (50 –100 cm) to deep (> 100 cm).

Red and yellow massive earths are minor soils on granitic mountainous and hilly terrain with eucalypt woodlands and on similar terrain with acacia scrub over sedimentary rocks. They have a sandy loam to sandy clay loam surface that grades into red or yellow sandy clay loam to sandy clay subsoil. Soil profiles have massive structure, acid pH and are non-sodic.

The red and brown structured earths occur on mountainous and hilly terrain with vine forest. The soils have a moderately to strongly structured loam to clay loam surface that grades into strong, finely structured light clay to medium clay subsoil. The profiles are acid and non-sodic throughout and depth varies from moderately deep to deep.

Red or yellow sodic duplex soils are common on the low hills and rises overlying acid to intermediate volcanics, pyroclastics and sedimentary rocks. The soils have a grey hard setting sandy loam to sandy clay loam surface grading into a similarly textured bleached subsurface that abruptly overlies moderately structured medium clay to heavy clay subsoil. The subsoil is acid and sodic. Profile depth varies from moderately deep to deep and rock bars with shallow stony sandy loams and loams are commonly associated. The soils are very similar to Pindi soil mapped on the same geology in the Mackay canelands (Holz and Shields 1985).

Bleached mottled duplex soils occur throughout most landscapes within the infill area, apart from those derived from granite. They are prominent on the low hills, rises and plains with eucalypt woodlands and brigalow and on the alluvial plains of major streams. The soils have a grey to brown hard setting sandy loam to clay loam surface and similarly textured bleached subsurface that abruptly overlies a mottled grey, yellow, brown or black medium clay to heavy clay subsoil. Structure in the surface and subsurface layers varies from massive to weak but the clay subsoil has moderate to strong coarse structure. The surface and subsurface have acid to neutral pH and the clay subsoil is mainly neutral to alkaline but may be slightly acid. The clay subsoil is generally sodic and often strongly sodic.

Soils under brigalow tend to have more profiles with dark grey, brown and black subsoil whereas yellow and grey subsoil colours are dominant under the eucalypt woodlands. Profiles with a red to brown clay subsoil are common on relict levees of the alluvial plains and on intermediate volcanics and pyroclastic rocks.

The sandy bleached mottled duplex soils are very similar except for having sandy loam to sandy clay loam surface and subsurface layers and clay subsoil with sand evident. They occur on granitic low hills and rises, footslopes and local alluvium derived from this terrain.

Gravelly bleached (fine sandy) duplex soils are restricted to land surrounding Funnel Creek upstream of Prospect Creek. They occur on footslopes and fans within low hills and rises overlying acid to intermediate volcanics, pyroclastics and sedimentary rocks. The soils have a grey fine sandy loam to fine sandy clay loam surface layer that grades into a bleached subsurface layer of similar texture. The subsurface layer abruptly overlies mottled grey and yellow light medium clay to heavy clay subsoil although abundant gravel often occurs at this boundary and continues into the upper subsoil. The surface and subsurface layers are at least 30 cm thick and are massive and hard setting. The clay subsoil has moderate to strong structure, a slightly acid to neutral pH and is sodic. The soils are generally deep and are very similar to Ossa soil mapped on the same geology in the Mackay canelands (Holz and Shields 1985).

Grey and black clays occur on rises and plains under brigalow, on low hills and rises overlying basalt, intermediate to basic volcanics and pyroclastic rocks and on alluvial plains. The soils have a thin surface layer of light medium clay to medium heavy clay that grades into medium clay to heavy clay subsoil. The surface may have strong fine (self-mulching) structure or be coarsely structured and hard setting. The subsoil has strong medium to coarse structure. Soil depth varies from 50 cm to more than 1 m on the volcanics and pyroclastics and is generally more than 1 m elsewhere. Some brigalow clays have intense melonhole gilgai microrelief.

The brown and red clays occur on rises and plains with brigalow and softwood scrub on weathered basalt. The soils have a thin surface layer of clay loam to medium clay that grades into light medium clay to heavy clay subsoil. The surface generally has strong fine (self-mulching) structure and the subsoil has strong fine to medium structure. Soil depth varies from moderately deep to deep. Not all profiles exhibit seasonal cracking.

Table 2. Soils of the infill area

Soil group	Australian soil classification [1]	Distinguishing characteristics
Shallow stony sand loams and loams	Leptic Tenosols and Leptic Rudosols	Shallow stony sandy loams and sandy clay loams overlying rock or gravel by 50 cm
Bleached sands and sandy loams	Bleached-Orthic Tenosols	Shallow gravelly sands and sandy loams with a bleached subsurface that directly overlies rock or gravel
Shallow stony clay loams and clays	Clastic Rudosols and Brown and Black Dermosols	Shallow stony brown and black clay loams and clays overlying rock or gravel by 50 cm
Gravelly black loams and clay loams	Chernic-Leptic Tenosols and Clastic Rudosols	Gravelly black sandy loams, loams and clay loams that overlie buried soil materials and gravel beds at variable depth
Red and brown earthy sands	Orthic Tenosols	Sands and sandy loams that are massive, acid and non-sodic
Red and yellow massive earths	Red and Yellow Kandosols	Gradational soils with a sandy loam to sandy clay loam surface that grades into red or yellow sandy clay loam to sandy clay subsoil that is acid and non-sodic
Red and brown structured earths	Red and Brown Ferrosols	Gradational soils of variable depth with a loam to clay loam surface that grades into strongly structured red to brown clay subsoil that is acid and non-sodic
Red and brown podzolics	Red and Brown Chromosols	Texture contrast soils with a loam to clay loam surface and bleached subsurface abruptly overlying red or brown clay subsoil that is acid and non-sodic
Sandy red and brown podzolics	Red and Brown Chromosols	Texture contrast soils with a sandy to sandy clay loam surface and bleached subsurface abruptly overlying red or brown (sandy) clay subsoil that is acid and non-sodic
Red or yellow podzolics	Red and Yellow Chromosols	Texture contrast soils with a sandy to clay loam surface and pale or bleached subsurface abruptly overlying red or yellow clay subsoil that is acid and non-sodic
Sandy red or yellow podzolics	Red and Yellow Chromosols	Texture contrast soils with a sandy surface and bleached subsurface abruptly overlying red or yellow (sandy) clay subsoil that is acid and non-sodic
Red or yellow sodic duplex soils	Red and Yellow Sodosols	Texture contrast soils with a sandy to loamy surface and bleached subsurface abruptly overlying red or yellow clay subsoil that is acid and sodic

Soil group	Australian soil classification [1]	Distinguishing characteristics
Bleached mottled duplex soils	Yellow and Grey Sodosols	Texture contrast soils with a sandy to loamy surface and bleached subsurface abruptly overlying mottled yellow, grey and brown clay subsoil that is neutral to alkaline and sodic
Sandy bleached mottled duplex soils	Yellow and Grey Sodosols	Texture contrast soils with a sandy loam to sandy clay loam surface and bleached subsurface abruptly overlying mottled yellow, grey and brown (sandy) clay subsoil that is neutral to alkaline and sodic
Gravelly bleached grey (fine sandy) duplex soils	Grey and Yellow Sodosols	Texture contrast soils with a fine sandy loam to fine sandy clay loam surface and bleached subsurface abruptly overlying mottled grey and yellow gravelly clay subsoil that is neutral and sodic
Grey and black clays	Grey and Black Vertosols	Dark grey to black medium to heavy clays
Brown and red clays	Brown and Red Vertosols and Brown and Red Dermosols	Brown to red light medium clays to heavy clays

Notes:

1. In the absence of laboratory data, interpretation of sodicity and acidity has been derived from field assessments of texture, structure and field pH.
2. Diagnostic criteria involving laboratory data for the Australian soil classification (Isbell 1996) are inferred from field descriptions.

3.4 Vegetation

The Queensland Herbarium has mapped and described native plant communities within the infill area as part of its statewide remnant vegetation mapping for implementation of the Vegetation Management Act. Eucalypt woodlands dominate the native vegetation and form the most common communities on all landform patterns. The woodlands originally occupied at least 83% of the infill area. This figure includes woodlands along the wetter eastern flank of the southern section which have swamp mahogany as a prominent component.

Softwood scrub and vine forest occurred on mountains, hills and some rises in the higher rainfall areas. The communities covered 9.3% of the area although this figure includes eucalypt woodlands that are often intermingled with them.

Lancewood, bendee and rosewood scrub occurred on mountainous and hilly terrain in the west, covering 5% of the area. Eucalypt woodlands are closely associated with the acacia scrub.

Brigalow scrub covered 2% of the infill area, spread across numerous isolated patches.

Natural grasslands occurred as very small isolated patches in the northern section, occupying less than 1% of the infill area.

Extensive areas of native vegetation remain within the area. The Herbarium mapped native vegetation on 341,615 ha at June 2001. This represents almost 79% of the infill area.

The remaining land was mapped as either cleared or significantly disturbed. The most extensive disturbance, including clearing, in the northern section has occurred on the rises and plains with eucalypt woodlands although such areas represent only 26% of the land zone.

Land within the northern section has also been preferentially disturbed or cleared on the:

- rises and plains with softwood scrub (91%);
- rises and plains with brigalow scrub (75%);
- hills with softwood scrub and vine forest (51%); and
- rises and plains with grasslands (44%), which have been cropped.

Substantial clearing has also occurred on the hills, low hills and rises with eucalypt woodlands.

Disturbance (including clearing) in the southern section has been most extensive on the low hills and rises with eucalypt woodlands. Approximately 55% of eucalypt and swamp mahogany woodlands in the wetter areas has been disturbed and almost 21% of the drier eucalypt woodlands has been disturbed.

Preferentially clearing has also occurred on the rises and plains with brigalow scrub (57%) and on the alluvial plains with eucalypt woodlands (45%).

Substantial parts of the rises and plains with eucalypt woodlands have also been cleared.

3.5 Land zones

Land zones represent a subdivision of the landscape based primarily on landform patterns (such as mountains, low hills, plains) and major vegetation patterns (eucalypt communities versus vine forest versus acacia scrub). Within each zone individual land systems are distinguished due to differing geology, modal slopes, soils and plant communities.

Twelve land zones have been delineated within the infill area. Their distribution is shown in Figure 2 and the area of each zone is given in Table 3.

Low hills and rises with eucalypt woodlands (and swamp mahogany in the wetter south east) are the dominant landscape feature, covering more than 30% of the infill area. The low hills and rises often merge with less dissected rises and plains containing eucalypt woodlands and the combined zones represent almost 48% of the area.

Mountains with eucalypt woodlands form the second largest land zone covering almost 25% of the area. Eucalypt woodlands are also associated with softwood scrub, vine forest and acacia scrub on mountainous terrain, covering almost 14% of the area.

Table 3. Land zone coverage within the infill area

Land zone	Area	
	(ha)	**(%)**
Mountains with eucalypt woodlands	107,390	24.7
Mountains with softwood scrub/vine forest and eucalypt woodlands	38,010	8.8
Mountains with acacia scrub/eucalypt woodlands	21,710	5.0
Hills with eucalypt woodlands	28,690	6.6
Hills with softwood scrub/vine forest	1,600	0.4
Hills with acacia scrub	270	<0.1
Low hills and rises with eucalypt and swamp mahogany woodlands	43,100	9.9
Low hills and rises with eucalypt woodlands	88,090	20.3
Rises and plains with eucalypt woodlands	76,600	17.6
Rises and plains with softwood scrub	590	0.1
Rises and plains with brigalow scrub	8,610	2.0
Rises and plains with grasslands	1,650	0.4
Alluvial plains with eucalypt woodlands	18,020	4.1
Total	**434,330**	**100.0**

Notes:

Acacia scrub refers to lancewood and bendee low closed forests and rosewood low open forests

Hills with eucalypt woodlands cover almost 7% of the area and alluvial plains with eucalypt woodlands cover slightly more than 4%. Hills with vegetation other than eucalypt represent than 1% of the infill area and rises and plains with similar vegetation account for 2.5 %.

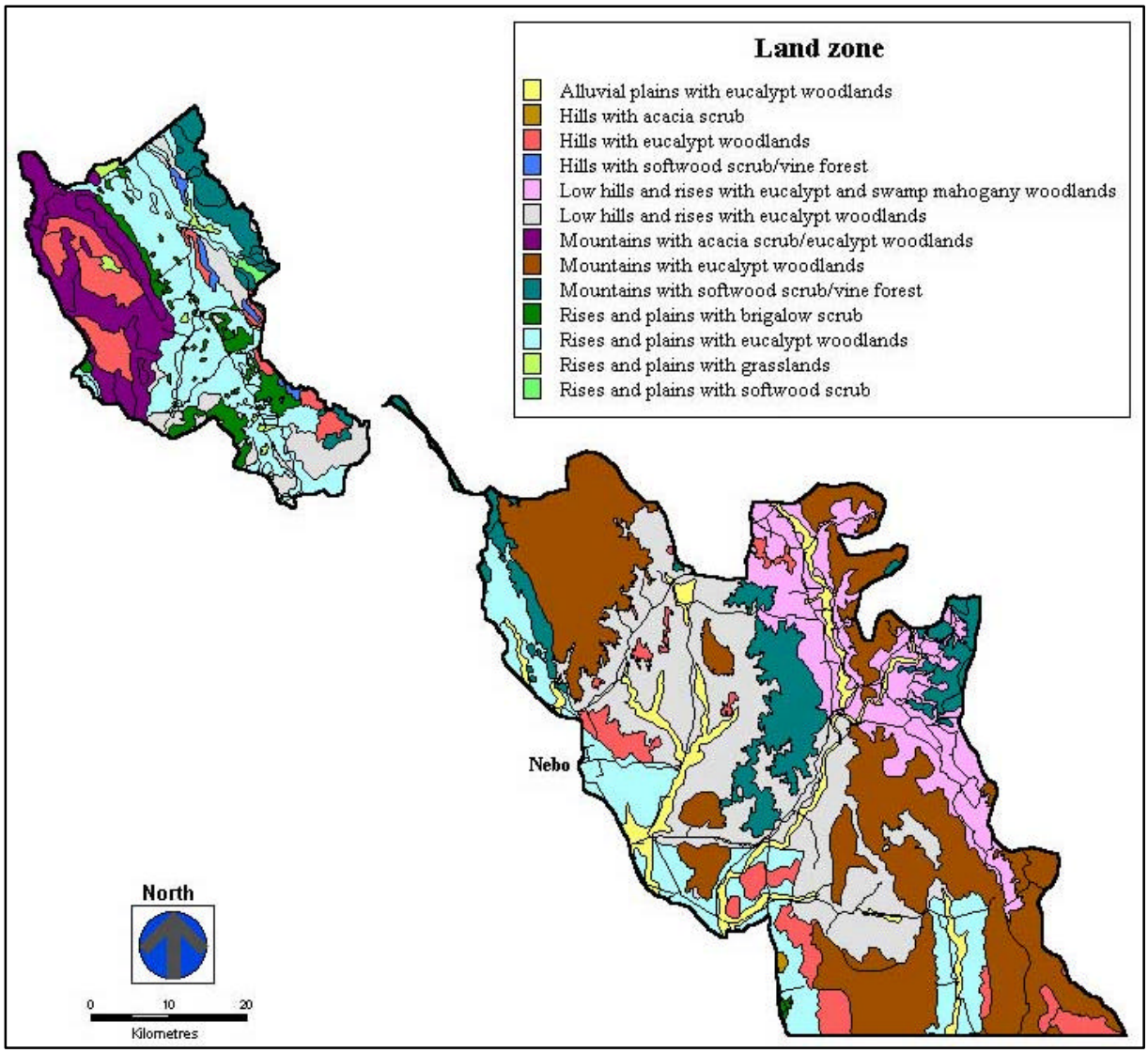


Figure 2. Land zones

4. Land systems

Twenty-six land systems have been delineated within the infill area. Their distribution is shown on the accompanying map and their relative areas are given in Table 4. A key to identifying the land systems is provided in Annex A.

4.1 Land systems from adjacent surveys

Twenty land systems previously identified in the adjacent surveys have been extended into the infill area as shown in Table 3. Detailed descriptions of the land systems from the Nogoa-Belyando catchment (Gunn et al. 1967) and Isaac-Comet area (Story et al. 1967) are provided in the appropriate survey report. Summary descriptions of land systems originating in the Capricornia coast survey are provided on the published map (Forster and Barton 1995).

In some instances different names have been used to describe what is essentially the same land system where mapped separately in the adjacent survey areas. Where these overlapping land systems extend into the infill area a combined name has been adopted resulting in two land systems named Connors/Alpha and Cotherstone/Hope.

Part of Nebo land system from the Isaac-Comet area has been split into Macksford land system on the Capricornia coast. This split has been followed for the infill area with Macksford being retained for land that is similar to that mapped on the Capricornia coast. Macksford land system within the infill area equates to land units 2 and 3 of Nebo land system from the Isaac-Comet area. Land mapped as Nebo land system within the infill area equates to Nebo land units 1 and 3 from the Isaac-Comet.

The original “central” concept for some land systems extrapolated from the Capricornia coast is based on land situated at considerable distance from the infill area. A few soil and vegetation characteristics of these land systems change progressively north.

The shallow to moderately deep red and brown clays and gradational clay loams that dominate Macksford land system on the Capricornia coast are replaced by shallow to moderately deep grey and black clays. The vegetation on these soils also changes to grassy open woodlands of mountain coolabah.

Poplar gum becomes a prominent species on Glassford and Chalmers land systems within the infill area and swamp mahogany with lesser poplar gum also form a significant part of the vegetation on Croydon land system along the wetter eastern flanks of the southern section.

4.2 New land systems

Six new land systems have been identified during this survey and are described in this report. Their component land units are based primarily on landform and soil differences. Vegetation information was not sufficiently detailed to establish whether plant communities differed significantly between most land units within a land system.

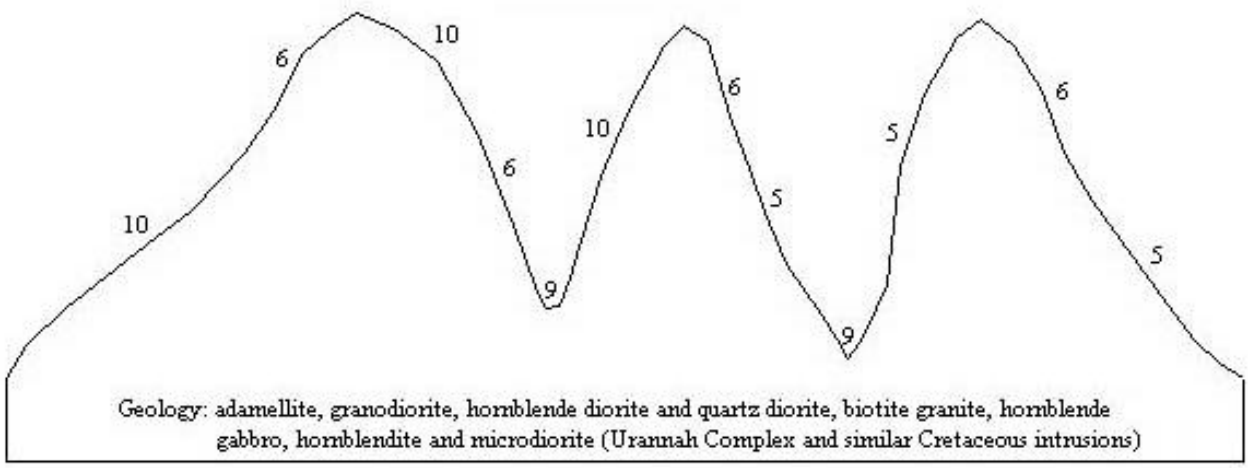
Because of the steep mountainous terrain no observations were undertaken within land delineated as Blue Mountain land system. Only 1 field site was within Murray land system and only 5 sites within Jordan land system. Delineation and description of these mapping units is based mainly on available published data, supported by some extrapolation of information recorded in the field recorded for sites in less undulating though similar terrain.

Table 4. Land system coverage of the survey area

Land system	Original survey description	Area	
		(ha)	(%)
Mountains with eucalypt woodlands			
Croydon	Capricornia coast	42,200	9.7
Murray	new	65,190	15.0
Mountains with softwood scrub/vine forest and eucalypt woodlands			
Blue Mountain	new	18,920	4.4
Britton	Isaac-Comet	14,670	3.4
Jordan	new	4,420	1.0
Mountains with acacia scrub/eucalypt woodlands			
Carborough	Isaac-Comet; Nogoa-Belyando	21,710	5.0
Hills with eucalypt woodlands			
Chalmers	Capricornia coast	11,590	2.7
Glassford	Capricornia coast	7,850	1.8
Planet	Isaac-comet	9,250	2.1
Hills with softwood scrub/vine forest			
Bedourie	Isaac-Comet	1,600	0.4
Hills with acacia scrub			
Durrandella	Isaac-Comet; Nogoa-Belyando	270	<0.1
Low hills and rises with eucalypt and swamp mahogany woodlands			
Bolingbroke	new	31,630	7.3
Glensfield	new	11,470	2.6
Low hills and rises with eucalypt woodlands			
Cotherstone/Hope	Isaac-Comet (Cotherstone); Nogoa-Belyando (Hope)	10,860	2.5
Strathdee	new	77,230	17.8
Rises and plains with eucalypt woodlands			
Hillalong	Isaac-Comet; Nogoa-Belyando	29,640	6.8
Macksford	Capricornia coast	35,730	8.2
Nebo	Isaac-Comet	11,230	2.6
Rises and plains with softwood scrub			
Racecourse	Isaac-Comet	590	0.1
Rises and plains with brigalow scrub			
Blackwater	Isaac-Comet; Nogoa-Belyando	110	<0.1
Daunia	Isaac-Comet	6,390	1.5
Humboldt	Isaac-Comet; Nogoa-Belyando	40	<0.1
Kinsale	Nogoa-Belyando	1,880	0.4
Somerby	Isaac-Comet; Nogoa-Belyando	190	<0.1
Rises and plains with grasslands			
Oxford	Isaac-Comet; Nogoa-Belyando	1,650	0.4
Alluvial plains with eucalypt woodlands			
Connors/Alpha	Isaac-Comet (Connors); Nogoa-Belyando (Alpha)	18,020	4.1
Total		**434,330**	**100.0**

Blue Mountain Land System

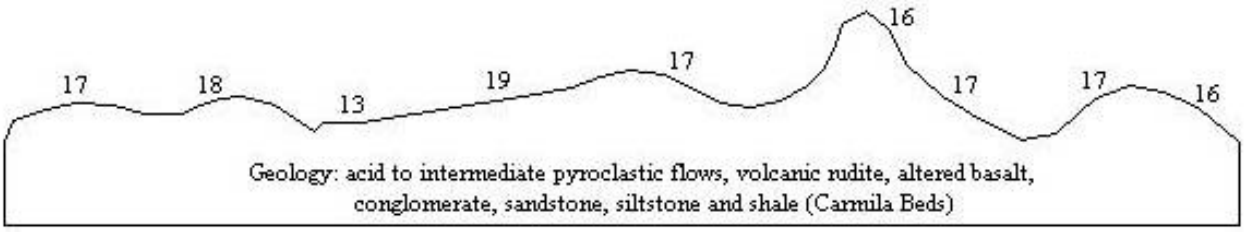
Steep granitic mountains with vine forest and eucalypt woodlands on shallow to moderately deep red and yellow texture contrast soils and red and brown structured earths



Land unit	Area (%)	Landform	Soils	Remnant native vegetation
5	30	Steep to very steep slopes and crests (>30%)	Shallow to deep red or yellow podzolics; Shallow to deep red and brown structured earths	Notophyll rainforest/microphyll vine forest with or without hoop pine
10	50		Shallow to moderately deep red and brown structured earths; Shallow to moderately deep red or yellow podzolics	Notophyll rainforest/microphyll vine forest with or without hoop pine
6	15	Rolling to steep slopes and crests (>15%)	Shallow stony sand loams and loams	Notophyll rainforest/microphyll vine forest with or without hoop pine; Tall woodland of lemon scented gum, stringybark, narrow leaved ironbark, bloodwood and swamp mahogany
9	5	Valley flats (0-2%)	Gravelly black loams and clay loams; Deep bleached mottled duplex soils	Tall open forest of blue gum, Moreton Bay ash, bloodwood and swamp mahogany

Bolingbroke Land System

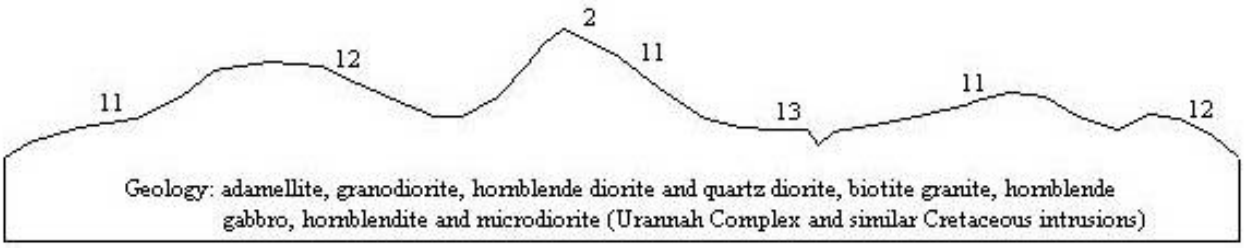
Undulating low hills and rises on acid to intermediate volcanics and sedimentary rocks with eucalypt and swamp mahogany woodlands over moderately deep red and yellow Sodosols



Land unit	Area (%)	Landform	Soils	Remnant native vegetation
16	10	Upper slopes and crests on low hills and as rock bars throughout rises (3-15%)	Shallow bleached sands and sandy loams	Woodland of narrow leaved ironbark, blue gum, bloodwood, lemon scented gum and stringybark
17	60	Gentle slopes and crests (2-10%)	Moderately deep red or yellow sodic duplex soils	Woodland of narrow leaved ironbark, blue gum, bloodwood, poplar gum, stringybark, and swamp mahogany
18	5	Mid slopes to crests (2-10%)	Deep sandy red or yellow podzolics	Woodland of bloodwood, blue gum, poplar gum, Moreton Bay ash, swamp mahogany and tea-tree
19	20	Footslopes and fans (1-3%)	Deep gravelly bleached (fine sandy) grey duplex soils	Woodland of blue gum, poplar gum, bloodwood, Moreton Bay ash, swamp mahogany and tea-tree
13	5	Valley flats (0-2%)	Deep bleached mottled duplex soils; Deep grey and black clays	Grassy open woodland of blue gum with occasional swamp mahogany and bloodwood

Glensfield Land System

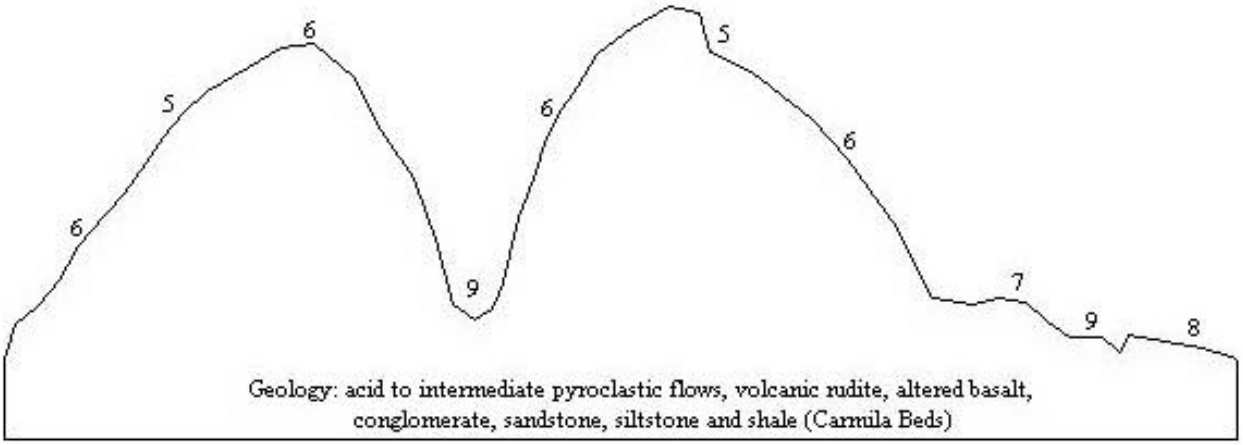
Undulating granitic rises and occasional low hills with eucalypt and swamp mahogany woodlands on moderately deep yellow and grey Sodosols



Land unit	Area (%)	Landform	Soils	Remnant native vegetation
2	10	Steep upper slopes and crests (6-15%)	Moderately deep bleached sands and sandy loams; Shallow sandy red and brown podzolics	Woodland of narrow leaved ironbark, blue gum, bloodwood, lemon scented gum, stringybark and swamp mahogany
12	10		Deep sandy red and brown podzolics	
11	70	Gentle slopes (1-10%)	Moderately deep sandy bleached mottled duplex soils	Woodland of narrow leaved ironbark, blue gum, bloodwood, poplar gum and swamp mahogany
13	10	Valley flats (0-2%)	Deep bleached mottled duplex soils; Deep grey and black clays	Woodland to open forest of bloodwood, poplar gum, blue gum, Moreton bay ash with lower trees of swamp mahogany, tea-tree and pandanus Grassy open woodland of blue gum with occasional swamp mahogany and bloodwood

Jordan Land System

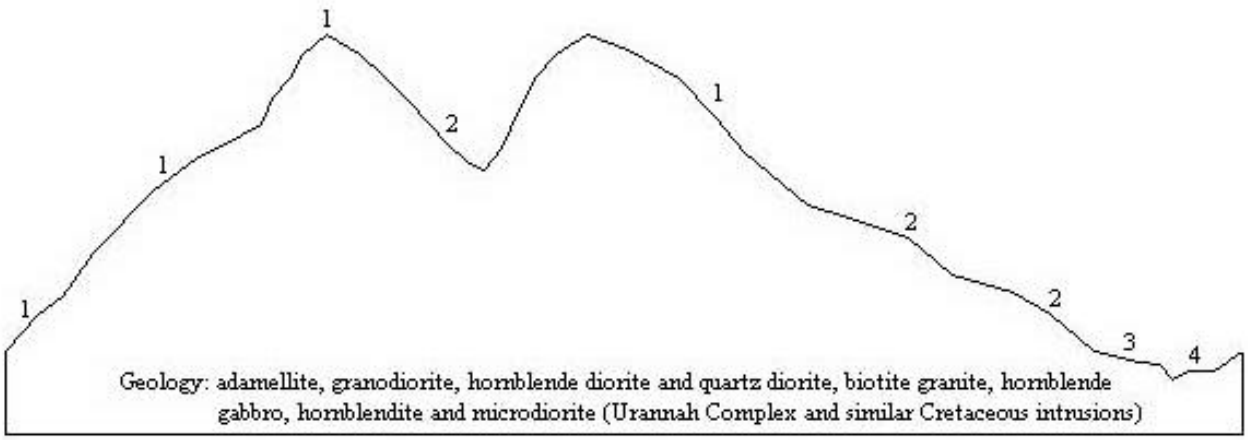
Rolling to steep mountains on acid to intermediate volcanics and sedimentary rocks with vine forest and eucalypt woodlands over moderately deep red and yellow texture contrast soils



Land unit	Area (%)	Landform	Soils	Remnant native vegetation
5	50	Steep to very steep slopes and crests (>30%)	Shallow to deep red or yellow podzolics; Shallow to deep red and brown structured earths	Complex to mixed notophyll rainforest, may have hoop pine emergents; Areas of lemon scented gum, stringybark, narrow leaved ironbark, bloodwood and swamp mahogany tall woodland
6	20		Shallow stony sandy loams and loams	
7	15	Gentle to moderate slopes and crests (5-15%)	Shallow to deep red or yellow podzolics; minor shallow stony sandy loams and loams	Complex to mixed notophyll rainforest, may have hoop pine emergents; Areas of lemon scented gum, stringybark, narrow leaved ironbark, bloodwood, blue gum and swamp mahogany tall woodland
8	10	Gentle lower slopes and footslopes (2-8%)	Deep red or yellow podzolics	Complex to mixed notophyll rainforest Areas of bloodwood, poplar gum, blue gum and Moreton Bay ash woodland
9	5	Valley flats (0-2%)	Gravelly black loams and clay loams; Deep bleached mottled duplex soils	Tall open forest of blue gum, Moreton bay ash, bloodwood and swamp mahogany

Murray Land System

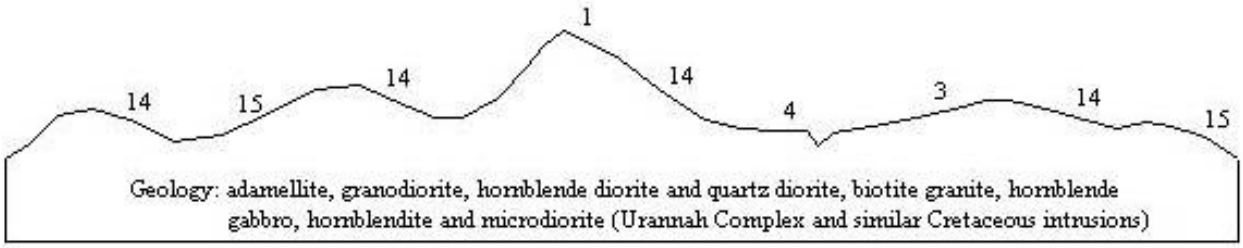
Steep to rolling granitic mountains with eucalypt woodlands on shallow stony sandy loams and loams and shallow sandy red and brown Chromosols



Land unit	Area (%)	Landform	Soils	Remnant native vegetation
1	60	Steep slopes and crests (>15%)	Shallow stony sandy loams and loams; Shallow sandy red and brown podzolics	Woodland of lemon scented gum, stringybark, narrow leaved ironbark, blue gum, bloodwood and cabbage gum
2	25	Gentle to moderate upper slopes and crests (6-15%)	Shallow sandy red and brown podzolics; Moderately deep sands and sandy loams	Woodland of lemon scented gum, stringybark, narrow leaved ironbark, blue gum, bloodwood and cabbage gum Complex to mixed notophyll rainforest in protected sites
3	10	Footslopes and fans (1-6%)	Deep sandy red and brown podzolics	Woodland of lemon scented gum, stringybark, narrow leaved ironbark, blue gum, bloodwood and cabbage gum Complex to mixed notophyll rainforest in protected sites
4	5	Valley flats (0-2%)	Deep red and brown earthy sands; Deep bleached mottled duplex soils	Woodland of blue gum, Moreton bay ash, bloodwood, poplar gum and swamp mahogany in wetter areas Grassy woodland of poplar box in drier areas

Strathdee Land System

Undulating granitic low hills and rises with eucalypt woodlands on sandy red and brown Chromosols



Land unit	Area (%)	Landform	Soils	Remnant native vegetation
1	5	Steep slopes and crests (>15%)	Shallow stony sandy loams and loams; Shallow sandy red and brown podzolics	Woodland of narrow leaved ironbark, gum topped bloodwood and cabbage gum
14	60	Gentle to moderate slopes and crests (1-15%)	Moderately deep sandy red and brown podzolics; minor deep sandy bleached mottled duplex soils	Woodland of narrow leaved ironbark, gum topped bloodwood and cabbage gum
15	20	Gentle to moderate lower to mid slopes (1-15%)	Moderately deep bleached sands and sandy loams	Woodland of narrow leaved ironbark, gum topped bloodwood, cabbage gum, blue gum and Moreton bay ash
3	10	Footslopes and fans (1-6%)	Deep sandy red and brown podzolics	Woodland of narrow leaved ironbark, gum topped bloodwood, blue gum and Moreton bay ash Shrubby woodland of poplar box and cabbage gum
13	5	Valley flats (0-2%)	Deep bleached mottled duplex soils; Deep grey and black clays	Woodland of gum topped bloodwood, bloodwood, poplar gum, blue gum, Moreton bay ash or shrubby woodland of poplar box and cabbage gum Grassy open woodland of blue gum with occasional swamp mahogany and bloodwood

5. Acknowledgements

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Annex A
Key to land systems

Mountains with eucalypt woodlands
- On granitic rocks (steep to rolling) ..... Murray
- On acid-intermediate volcanics (rolling to steep) ..... Croydon

Mountains with softwood scrub/vine forest (and eucalypt woodlands)
- On granitic rocks (steep) ..... Blue Mountain
- On acid to intermediate volcanics (steep) ..... Britton
- On sedimentary rocks and volcanics (rolling to steep) .....Jordan

Mountains with acacia scrub/eucalypt woodlands
- On sedimentary rocks (steep) ..... Carborough

Hills with eucalypt woodlands
- On granitic rocks (steep to rolling) .....Glassford
- On acid to intermediate volcanics (rolling to steep) .....Chalmers
- On coarse grained sedimentary rocks (undulating) ..... Planet

Hills with softwood scrub/vine forest
- On basalt (rolling) .....Bedourie

Hills with acacia scrub
- On sedimentary rocks (rolling to undulating) ..... Durrandella

Low hills and rises with eucalypt and swamp mahogany woodlands
- On granitic rocks (undulating) .....Glensfield
- On sedimentary rocks and volcanics (undulating) ..... Bolingbroke

Low hills and rises with eucalypt woodlands
- On granitic rocks (undulating) ..... Strathdee
- On sedimentary rocks (rolling) ..... Cotherstone/Hope

Rises and plains with eucalypt woodlands
- On sedimentary rocks (undulating) ..... Hillalong
- On intermediate volcanics and greenstone (undulating)..... Macksford
- On unconsolidated sediments (gently undulating) .....Nebo

Rises and plains with softwood scrub
- On weathered basalt (gently undulating) .....Racecourse

Rises and plains with brigalow scrub
- On weathered basalt (undulating to gently undulating) ..... Kinsale
- On weathered sedimentary rocks (gently undulating) .....Daunia
- On unconsolidated sediments with duplex soils and clays (gently undulating).... Humboldt
- On unconsolidated sediments with non-gilgaied clays (gently undulating) ..... Blackwater
- On unconsolidated sediments with melonhole clays (level) ..... Somerby

Rises and plains with grasslands
On basalt .....Oxford

Alluvial plains with eucalypt woodlands
Higher plains, minor flooding .....Connors/Alpha

Notes:

1. Acacia scrub describes lancewood and bendee low closed forests and rosewood low open forests
2. Murray LS represents a more dissected version of Glassford LS
3. Macksford LS as mapped within the survey area is equivalent to land units 2 and 3 of Nebo LS from the Isaac-Comet area
4. Nebo LS as mapped within the survey area represents land units 1 and 3 of Nebo LS from the Isaac-Comet area

Annex B
List of Scientific names for mentioned plants

Common name	Scientific name
Bloodwood	Corymbia intermedia
Blue gum	Eucalyptus tereticornis
Cabbage gum	Corymbia papuana
Gum topped bloodwood	Corymbia erythrophloia
Hoop pine	Araucaria cunninghamii
Lemon-scented gum	Corymbia citriodora
Moreton Bay ash	Corymbia tessellaris
Mountain coolabah	Eucalyptus orgadophila
Narrow leaved ironbark	Eucalyptus drepanophylla and Eucalyptus crebra
Poplar box	Eucalyptus populnea
Poplar gum	Eucalyptus platyphylla
Stringybark	Eucalyptus acmeniodes
Swamp mahogany	Lophostemon suaveolens
Tea-tree	Melaleuca species