Queensland Government
Department of Main Roads
Road System & Engineering

SOILS OF WESTERN QUEENSLAND

WQ32

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1 Introduction

This technical note is one of several notes in the WQ series which contain background data on Western Queensland. Details of the scope and coverage of these notes can be found in the preface to the WQ series of Technical Notes.

This note discusses the details of the soils occurring in Western Queensland. It should be read in conjunction with the Technical Note on Geology and Geomorphology (WQ31).

This note, as well as some of the others, is accompanied by a CD which contains a Queensland Soils Map and soil database. The map has been interfaced with MapInfo. A viewer is included on the CD to allow limited map manipulation. Further manipulation will require the use of a full version of MapInfo.

2 General

Soils may be loosely defined as the surface layer of material derived from a combination of the weathering products of rocks and the products produced by biological action. Although soils are technically always formed insitu, the mineral constituents of soil may be either formed insitu (residual soils) or transported. If transported, the dominant modes of transport in Western Queensland are alluvial (water transport) and aeolian (wind transport). Some soils are ancient and formed under climatic conditions different from the current climate. The properties of a particular soil are a function of the original source rock which provided the detritus from which the soils formed, the transport mechanism which transported that detritus to the site, and the extent and nature of biological processes involved in the soil formation.

The soils developed in the western two-thirds of Queensland consist of a number of major soil types. The dominant soil type is a range of similar self-mulching grey cracking clay soils (commonly known as “black soil”) of either alluvial or residual origin. Alluvial black soils are dominant in the south and north, and the residual black soils are dominant in the central areas.

Sandy soils (including the Desert Loams) dominate in the far western desert areas.

Numerous areas of outcropping Tertiary strata, typically occupy either ancient alluvial areas which now occur adjacent to existing streams, or extensive, flat outwash plains. These areas are dominated by mixed clayey and sandy soils, which are often ferruginous.

3 Mapping

The entire continent is covered by 1:2 000 000 soil mapping, which forms part of the Atlas of Australian Soils (AoAS) (Northcote et al. 1960 to 1968). This map was captured at a scale of typically 1: 250 000. Sections of sheets 3, 4, 7 and 10 cover Queensland. A digital edition of the AoAS map (Bureau of Rural Sciences 1998) has been interfaced with the Department’s GIS system. This digital map was used to generate the Queensland Soil Map which is appended to this technical note. The full data set used, comprising the Queensland section of the AoAS and accompanying databases, are included on the CD which accompanies this note. This data has been converted to MapInfo GIS format. This data is a derivative of the Bureau of Rural Sciences data as detailed in the bibliography.

Other soil mapping, on which parts of the AoAS is based, is contained in the Western Arid Region Land Use Studies produced by QDPI between 1970 and 1990 or the “Lands of the ...” series published by the CSIRO in the 1950s and 1960s. The publications in these series cover individual project areas which together cover most of Western Queensland as well

as much of the coastal areas of the State. This data is also available in digital form but, unlike the AoAS data, it is not seamless. Individual project areas have been mapped using a classification system for soils and / or landforms, which may not correlate with the system adopted in the adjacent project areas.

The Department of Natural Resources (DNR) has recently published more detailed soils and/or land system maps covering selected areas of the State. Although none of this mapping is currently available for Western Queensland, the coverage area of this mapping is expanding, and in the future such mapping may become available for the west.

4 Definitions

AoAS: Atlas of Australian Soils. A seamless set of paper maps and a digital map, covering the entire continent at a scale 1: 2 000 000. Mapped using the Northcote system.

AoAS Code: Generally a two letter identifier used in the AoAS to identify similar soil types. The code may consist of either upper or lower case letters. The full code also contains a number following the leading letters. The codes have been included in this note as they are the link between the Soil Map and the soils database which is included on the CD accompanying this note.

Black soil: A clay soil, generally dark grey in colour, but varying from light grey to dark grey and occasionally red or yellow when dry. The term is not a strict soil classification but rather a non-specialist's term applied to a range of soils. It is internationally synonymous with "black cotton soil". Using Northcote's system, these soils are classified as Uniform Texture Profile Soils - Cracking Clays, Class Ug5.1.

Chroma: A numeric descriptor of colour used in the Munsell Soil Colour Chart; see also Value.

Earthy: A soil profile which shows a gradation (as opposed to a distinct) increase in texture down the profile.

Horizon: A soil layer within a soil profile having morphological characteristics and properties different from the adjacent layers. The horizons are termed A, B or C from top to bottom, and may be further subdivided into A1, A2 etc. where appropriate.

Pan: A hardened and / or cemented horizon in or below a soil profile.

Profile: A column, or description of a column, of soil extending from the surface to the parent rock.

Principal Profile Form (PPF): The ultimate classification descriptor achieved using Northcote's classification system.

Self-mulching soil: A soil, generally clay which, due to its structure, forms a loose surface mulch-like layer as the soil dries.

Soil: The dynamic natural system at the earth's surface composed of mineral and organic materials developed insitu by various processes into organised profiles or layers.

Solum: The upper one or two horizons of the soil profile which are influenced by the current soil processes.

Texture: The grading of the constituents of the soil, usually expressed as the relative proportions of clay, silt, sand and gravel. Texture commonly varies from horizon to horizon within a soil profile.

Value: A numeric descriptor of colour used in the Munsell Soil Colour Chart; see also Chroma.

5 Soil Classification

The classification system used in published data on Australian soils appears somewhat confusing in that there have been significant changes in terminology over the last 30 years. Generally no specific engineering soil mapping has been undertaken. The available mapping and classification systems have been developed for pedological and or agricultural purposes. Much of the published Western Queensland mapping is quite old and hence interpretation of this mapping will require some knowledge of now disused classification systems.

Three major classification systems, in order of development, which have been used in the available soil mapping are:

(i) the system detailed by Stace et al., 1968.

(ii) the system described by Northcote 1960.

(iii) the recently developed system of Isbell 1996.

Stace's system was the most commonly used system up to the early 1970's. It is essentially based on the work of Dokuchaev and his associates in Russia, and was applied to the Australian situation by Prescott in 1931. The system is based on the "Great Soil Groups". The original system had to be extensively broadened to enable it to be adapted to the Australian context. The system was based on northern European soils which were affected by glaciation, and was not always found to be applicable to the deep, old soil which developed on the generally non-glaciated terrain of Australia.

The Northcote system, which was generally used in the 1970s to late 1990s, is based on the recognition of the soil profile, i.e. typically in the depth range of 0.3m to 2m. The observed profile is then compared with a number of defined profiles to obtain the appropriate classification. The classification system is an open, tree-type system of between five and seven levels. The level of differentiation is firstly into "division", being into either Organic, Uniform, Gradation, or Duplex, and identified by a capital letter. The next level is a "subdivision" which is defined by texture, cracking, mineral content, or nature of the B horizon. This is identified by a lower case letter. Further differentiation is by sections (identified by a numeral followed by a decimal point), class (identified by the first numeral after the decimal point), and ultimately by a unique Principal Profile Form (PPF) by the second numeral after the decimal point. Subdivisions into classes are often based on colour and nature of the various soil horizons.

A PPF classified as a Um2.31, would be a uniform (U), medium-textured (m), showing pedological organisation including a conspicuous bleached A2 horizon (2.), one uniform pan, (3), value / chroma =4. (1). This is the system used in the AoAS, with some modification in that several AoAS Codes may refer to the one PPF, but not more than one PPF to a AoAS code. Since the PPF focuses on the soil profile, it does not directly address the genesis of the soil, which may be of particular interest in relation to the soil's engineering properties.

The Australian Soil Classification System (Isbell 1996 and Isbell et al. 1997) is a recent development and may become the successor to the previous systems. It is also an open system and has been designed to be amenable to computer storage of soil data. This classification is a multi-categoric scheme with classes defined on the basis of horizons and their arrangement in vertical sequences as observed in a vertical exposure of the soil profile.

When perusing a specific soil map, care must be exercised to ensure the reader is conversant with the classification system used. Even for maps within the same series, different classification systems maybe used.

All three classification systems are fundamentally different and although broad correlation between the various systems does occur, direct translation from one system to another system does require some care. Because of these problems a correlation table has been appended to this note, which allows some broad correlations between the various systems to be made.

None of the three systems is compatible with the generally used engineering classification system - the Unified Soil Classification system (USC). This system is based primarily on soil texture. Soil classification systems acknowledge that soil texture changes with depth. Hence an exclusive textural system such as the USC would result in several classes of soil being encountered within the one profile.

6 Soil Distribution

Soil types often follow the distribution of geological and geomorphological units, as described in the Technical Note on Geology and Geomorphology (WQ31). A typical transect from the east to west of the area covered by these notes is as follows: heavy red clay soils occur along the eastern margin of the area. The central section is dominated by cracking clay (black soil). The far western sector is dominated by sandy soils in the south, while in the north the soils are variable due to the complex geology of that area.

7 Soil Descriptions

The following section describes the five dominant soil types occurring in Western Queensland in approximate order of dominance. These five types cover over 95% of the area of the west.

- Cracking Clays (Ug5)
- Earths (Gn)

- Sandy Soils (Uc)
- Lithosols (Um)
- Desert Loams (Dr)

The above five soil types represent only a small part of the full range of soil types which occur in Queensland.

8 Cracking Clay (Ug5)

Cracking Clays Ug5 are commonly termed "Black Soils" or can also be defined as "Grey Brown and Red Clays" and "Black Earths". Black soils occupy approximately one third of the area of the State. They occur in three generic variants:

(i) residual black soil developed directly on deeply weathered sedimentary rock of the Rolling Downs Group of Cretaceous age. These soils typically occur in the Central West, and are generally classified as Classes Ug5.2 and Ug5.3 soils.

(ii) alluvial black soils are generally derived from weathering products of the Rolling Downs Group which have suffered appreciable transport, combined with sediments of Tertiary age. These soils occur south of the Warrego Highway and north of the Flinders Highway, as well as adjacent to existing drainage channels and streams. They are generally classed as Ug5.2.

(iii) residual black soil developed on Tertiary basalt deposits (Class Ug5.1). Such black soils occur in the Darling Downs, Central Highlands, and Northern Tablelands.

The following tables give the classification and details of cracking clays which occur in Western Queensland as shown in the AoAS.

Cracking Clays : Northcote Classification		
Key	**Code**	**Descriptor**
Division	U	Uniform profile forms
Sub div.	Ug	Fine textured, seasonal cracking
Section	Ug5	Pedological organisation, no A2 horizon

Cracking Clays AoAS description		
Soil	**Class**	**AoAS Code**
Residual Black Soil on Basalts	Ug 5.1	Ka, Kb, Kc, Kd, Ke, Kf
Alluvial Black Soil	Ug5.2	CC, II
Residual Black Soil on Rolling Downs	Ug 5.3 Ug5.2	MM CB

The typical engineering properties of these soils are as follows:

Black Soil - Engineering Properties			
Type Property	**Alluvial**	**Residual on Cretaceous**	**Residual on Basalt**
Class	Ug5.2	Ug5.3	Ug5.1
LL	40-60	40-70	60-90
PI	25-35	25-35	40-60
LS	12-18	15-20	15-25
USC	CL-CH	CL-CH	CH

9 Earths (Gn)

This group of soils is a mixed grouping consisting of red brown earths, calcareous red earths, yellow earths and the type dominant in the west, the red earths. These soils are characterised by a massive, predominately sandy texture, porous earthy soil materials and are yellow to red-brown to red in colour. Boundaries between the horizons are gradational. Clay content tends to increase with depth. A freshly cut soil exposure tends to have a rather dusty appearance as opposed to the shiny, slick appearance of similar but finer textured or more clayey forms.

The red earths tend to form on late Cainozoic floodouts and alluvial fans (mapped on the geological sheet as Czs) and are the dominant soil type in the area between the NSW border and a line from Moonie to Mitchell to Augathella to Emmet to Quilpie and then due south to the NSW border. They also occur in a band stretching from Yalleroi to a point 100km north of Hughenden. Numerous small patches of this soil type occur west of a line joining Quilpie to Camooweal. The yellow earths dominate in a similar geological setting along the western flank of the Great Dividing Range between Jericho and Charters Towers. The following tables give the

classification and details of more significant forms of earths which occur in Western Queensland as shown in the AoAS.

Earths: Northcote Classification			
Key	**Code**	**Descriptor**	**AoAS Code**
Division	G	Gradational profile	
Sub div.	Gn	Non Calcareous	
Section	Gn2	Sandy fabric	
Class	Gn2.1	Red earths	Mu, Mw, Mx, My, Mz
Class	Gn2.2	Yellow earths	MR, Mr, MS, Ms
Class	Gn2.4	Brown earths	MK, Mn
Class	Gn2.6	Mottled yellow earths	MO, MP, Mt, MV
Class	Gn2.7	Mottled yellow leached earths	Mb
Class	Gn2.8	Grey earths	CM, Mc, Mq, QM
Class	Gn2.9	Grey leached earths	MT, TM
Section	Gn3	Smooth ped fabric	
Class	Gn3.1	Red friable earths	Mj, Mn, Mo, Mp
Class	Gn3.2	Brown friable earths	MD, ME, Me
Class	Gn3.4	Dark friable earths	Mm
Class	Gn3.5	Yellow brown friable earths	Mf, MW, WM
Class	Gn3.7	Yellow friable earths	MX
Class	Gn3.9	Grey friable earths	FM, MF

10 Sandy Soils (Uc)

These soils are characterised by often loose to poorly consolidated siliceous sand, often in the form of active or stabilised parallel sand dunes. Texturally the sand tends to be of one grain size, and patches of essentially loose sand are interspersed with sandy loam areas. Colour varies considerably but generally in red or yellow hues. Horizons within the soil are often effectively absent or only poorly developed. Generally a slight increase in clay content occurs down the profile.

The following tables give the classification and details of sandy soils which occur in Western Queensland as shown in the AoAS.

Sandy Soils: Northcote Classification			
Key	**Code**	**Descriptor**	**AoAS Code**
Division	U	Uniform profile forms	
Sub div.	Uc	Coarse textured	
Section	Uc1	Little or no soil development	A, B, BA, BY, Bz
Section	Uc2	Soil development, bleached A2	Ca, Cb, Cd
Section	Uc4	Soil development, not bleached A2	JJ, JK
Section	Uc5	Soil development, A2 absent	AA, AB, AC, AD

11 Lithosols (Um)

These soils are essentially stony or gravelly soils generally lacking in horizon development, other than the localised development of a surface horizon containing some organic material. They are shallow sands, loams, and clay loams and usually contain a large proportion of coarse textured rock material. This stoniness and lack of soil development are the characteristics of the profile.

They are typically found on the mesas and the remnants of mesas and on areas of lateritised remnants of tertiary, and to a lesser extent cretaceous, sedimentary rocks. Geologically they are found on tertiary sedimentary rocks mapped as T or Tm. In Western Queensland they are commonly found in patches in a north northwest trending band stretching from Thargomindah to Doomadgee.

The following tables give the classification and details of lithosols which occur in Western Queensland as shown in the AoAS.

Lithosols: Northcote Classification			
Key	**Code**	**Descriptor**	**AoAS Code**
Division	U	Uniform profile forms	
Sub Div.	Um	Medium textured	
Section	Um1	Little or no pedological organisation	Fx, Fy, Fz
Section	Um2	Pedological organisation, bleached A2	Fu, FV
Section	Um4	Pedological organisation unbleached A2	LK, LL, LM, LN
Section	Um5	Pedological organisation, A2 absent	BB, BE, F, Fa, Fb, Fc, Fd, Fp
Section	Um6	Pedological organisation, peds evident, A2 absent	Gb, Gd, Ge, Gf, Gh, Gk

12 Desert Loams (Dr)

These soils are characterised by the existence of red to yellow to grey gidgee stone up to 200mm diameter on the surface. The soils have a marked texture contrast with a thin loamy and stony A horizon overlying a clayey B horizon. The surface soil tends to be brownish to red in colour while the subsoil tends to be red. The soil is generally alkaline and boundaries between the horizons are distinct.

The red desert loams tend to form in Cainozoic dune fields (mapped on the geological sheet as Czs). They are the dominant soil type in the area bounded by the South Australian border and Innaminca to Morney to Bedourie and Birdsville.

The following tables give the classification and details of desert loams which occur in Western Queensland as shown in the AoAS.

Desert Loams: Northcote Classification			
Key	**Code**	**Descriptor**	**AoAS Code**
Division	D	Duplex forms	
Sub div.	Dr	Red clayey subsoils	
	Dr1	Crusty loamy soils with red clay subsoil	Nd, Nd
Section	Dr2	A horizon hardsets, B coloured	Oa, Pa, Qa,| Pb, Qb, Oc, Pc, Qc, Pf, Ph
Section	Dr3	A horizon hardsets, B mottled	Qj, Ok, Pk
Section	Dr4	A horizon does not set, B coloured	Qs

13 Bibliography

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14 Author

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15 Appendix

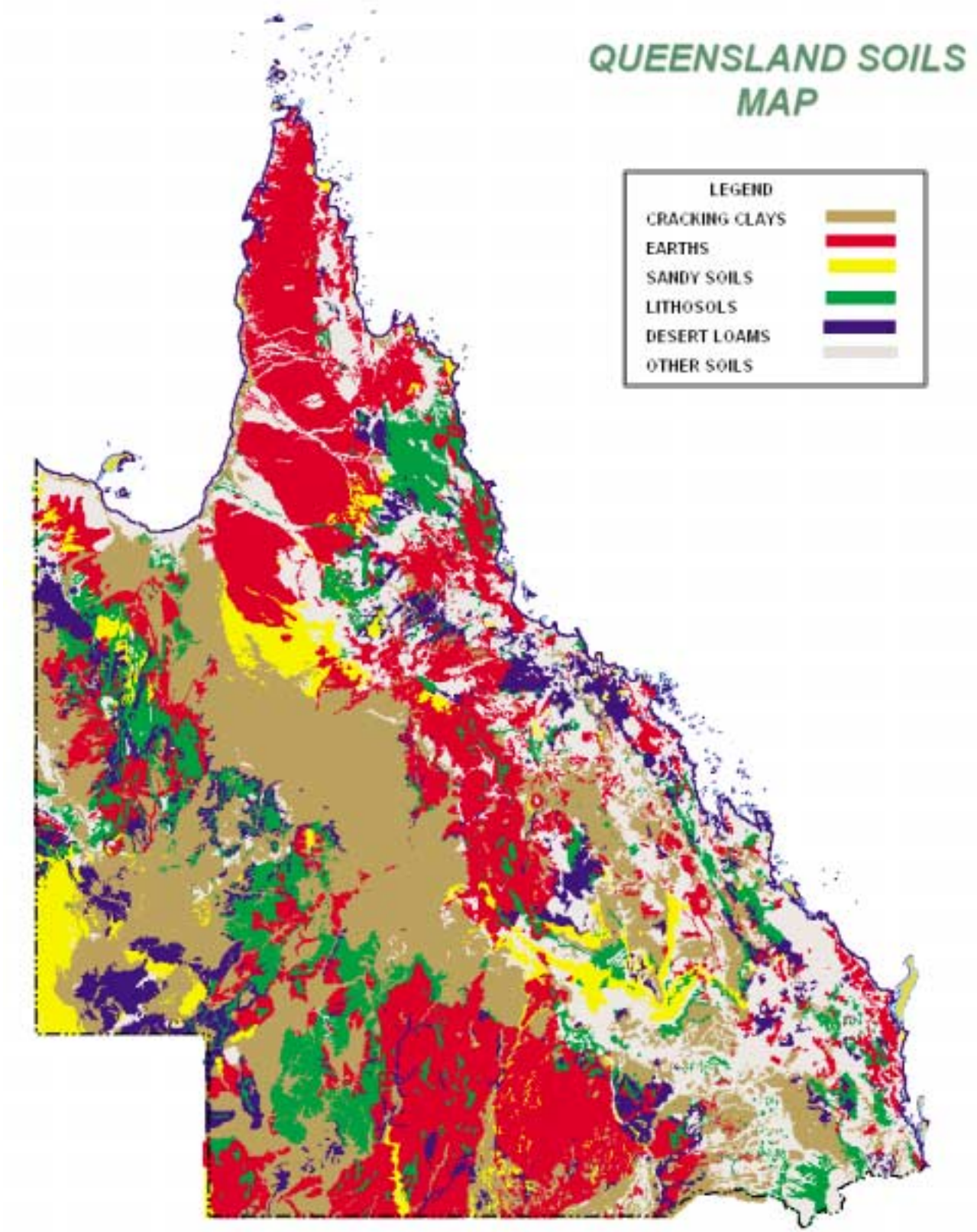
The following table and map are included in the Appendix.

Table 1. Approximate Correlation between Various Soil Classification Systems.

Map 1. Queensland Soils.

Order (Isbell 1996)	**Great Soil Group** (Stacey et al 1968)	**Factual Key** (Northcote 1960)	**This Technical Note**
AROSOLS	Solonised brown soils, grey-brown and red calcareous soils	Gc1, Gc2, Um1, Um5 soils	
MOSOLS	Non-calcic brown soils, some red-brown earths and a range of podzolic soils	Many forms of duplex (D) soils	
MOSOLS	Prairie soils, chocolate soils, some red and yellow podzolic soils	Wide range of Gn3, soils some Um4	
RROSOLS	Krasnozems, euchrozems, chocolate soils	Gn3, Gn4, Uf5, Uf6 soils	
DROSOLS	Humic gleys, gleyed podzolic soils, solonchaks and some alluvial soils	Wide range of classes, Dg and some Uf6 soils probably most common	
NDOSOLS	Red, yellow and grey earths, calcareous red earths	Gn2, Um5 soils	Red Earths / Yellow Earths
UROSOLS	Many podzolic soils and soloths	Many strongly acid duplex soils	
ANOSOLS	Neutral to alkaline, and acid peats	Organic (O) soils	
ODOSOLS	Podzols, humus podzols, peaty podsols	Many Uc2, some Uc3, Uc4 soils	
UDOSOLS	Lithosols, alluvial soils, calcareous and siliceous sands, some solonchaks	Uc1, Um1, Uf1 soils	Lithosols
ODOSOLS	Solodized solonetz and solodic soils, some soloths and red-brown earths, desert loams	Many duplex (D) soils	Desert Loams.
ENOSOLS	Lithosols, siliceous and earthy sands, alpine humus soils and some alluvial soils	Many Uc and Um classes	Sandy Soils
RTOSOLS	Black earths, grey, brown and red clays	Ug5 soils	Black Soil / Cracking clays

Table 1 Approximate Correlation between Various Soil Classification Systems



Map 1 Queensland Soils