Queensland Government
Department of Main Roads
Road System & Engineering

GEOLOGY AND GEOMORPHOLOGY OF WESTERN QUEENSLAND

WQ31

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1 Introduction

This technical note is one of a series on notes regarding road construction issues in the three western MR Districts of Queensland.

Details of all the notes in the WQ series can be found in the Preface to the WQ Technical Notes. This note and its companion notes on soils and climate are more in the nature of background documents, compared to some of the other notes which are more specific to the physical process of road design and construction.

The current note discusses two fundamental aspects of the form of Western Queensland. The geology considers the surface rocks of the area, while the geomorphology considers the current surface terrain features.

Due to the critical nature of the soils, a separate technical note, WQ32, has been prepared on this subject. Likewise a separate note, WQ33, covers the types of road-making materials found in Western Queensland.

Appended to this note is a map of Queensland geology. This map was produced from the digital geological map of Queensland, and shows the distribution of rocks by age and rock type.

This note, as well as some of the other notes in this series, is accompanied by two CDs, one of which contains a Queensland Geology Map and geology database, and the other a number of maps and associated databases of land systems mapping. The maps have been interfaced with MapInfo. A viewer is included on the CD to allow limited map manipulation. Further manipulation of this data will require the use of a full version of MapInfo.

2 Structure of Technical Note

Geological structure - the broad structural elements of Western Queensland.

Stratigraphy - the geological sequence of the various rock strata in order from the oldest to youngest. Only those units which outcrop are discussed, although a unit which outcrops in one area may be covered by a younger unit in another area.

Geological history post-Jurassic - this section provides a more detailed history of the younger, post Jurassic age rocks which cover most of the area.

Geomorphology - this section covers the typical land forms which occur in the area and describes these land forms in terms of both mode of formation and underlying geology.

Materials - this section covers the interrelation of geology and land forms as sources of various classes of road making materials. This section interfaces with Technical Note WQ33.

3 Geological Structure

The following section discusses only details of the geology of Western Queensland. Perusal of the Queensland Geology Map will reveal that the eastern third of the State is much more complex than that of the remainder of the State.

The dominant geological structural element of Western Queensland is the Great Artesian Basin. This is a subhorizontal to gently dipping sequence of Mesozoic rocks occupying over 50% of the area of the State. The eastern rim of the basin is along the western edge of the Great Dividing Range and extends from southern New South Wales to almost the tip of Cape York. The north-western rim of the basin is the ancient rocks of the Cloncurry - Boulia - Mt Isa area, while in the south-west the basin is

overlaid by the sands of Simpson Desert. In the centre of the basin a total thickness of over 3000m of sedimentary rocks occur.

4 Stratigraphy

The Mount Isa Inlier and associated structural units are Proterozoic in age (1800-700 million years ago - Ma). They consist of meta-volcanics, meta-sediments and higher grade metamorphic, intruded by granites and dolerites. These rocks outcrop in a south-east trending band, typically 100km wide extending from the Northern Territory border to the Cloncurry - Hamilton - Mt Isa area. Proterozoic rocks are also located near the north-eastern boundary of the North Western District in the Georgetown area.

The Georgina Basin which contains rocks of Cambrian - Ordovician age (620-480 Ma), consists of sandstones, limestones and shales with minor dolerite and basalt. These rocks outcrop to the west and south-west of the Mt Isa Inlier. Relatively small outcrops of Devonian (430-420 Ma) and Permian (290-280 Ma) strata are located at the southernmost exposed limit of the Georgina Basin near Glenormiston.

Several small Devonian intrusions are exposed in the Hungerford-Eulo area. These represent the northernmost exposed limit of the Lachlan Fold Belt, a major structural feature which trends in a north-northwesterly direction through New South Wales.

The vast majority of the area of the three Districts is covered by "soft" Jurassic- Cretaceous (205-80 Ma) sedimentary strata of the Great Artesian Basin. This basin consists of three contiguous sub-basins the Carpentaria, Eromanga and Surat Basins. As a general guide, the Carpentaria Basin encompasses the north-flowing Gulf of Carpentaria Drainage Division; the Eromanga Basin encompasses the south-flowing Eyre and Bulloo Drainage Divisions; and the Surat Basin encompasses the northern limit of the Darling Drainage Division (although the Dawson River drains the northern part of the basin).

The eastern extremities of the Carpentaria and Eromanga Basins and the northern parts of the Surat Basin are delineated by arcuate bands of Lower Jurassic sandstones, siltstones and mudstones. To the east and north of these exposures lie a variety of Palaeozoic rocks, including "soft" mid-late Palaeozoic (390-215 Ma) rocks of the Bowen, Galilee and Drummond Basins and older "hard" rocks of the Anakie Inlier, the Lolworth - Ravenswood Block and the Georgetown Inlier.

The Carpentaria Basin is almost entirely obscured by Pliocene-Holocene (5-0 Ma) sediments. The most areally extensive outcropping unit is the fine-grained mid-Cretaceous Normanton Formation, which is a correlative of the Mackunda Formation to the south. Rare remnants of Paleocene-Eocene (60-40 Ma) sediments are located at the basin margins.

The most areally extensive Eromanga Basin unit is the late-Cretaceous Winton Sandstone. This unit is semi-enscribed (from Boulia to Julia Creek / Richmond to Augathella) by the underlying Mackunda Formation, Allaru Mudstone and Toolebuc Limestone. Although the various units are relatively thin, their very gentle dip results in them outcropping over a large proportion of the Western Queensland.

The Winton Sandstone is partly overlaid by extensive remnants of Paleocene-Eocene lateritised and silicified sediments (especially in the Jundah - Adavale area) and less common Miocene (20-10 Ma) silicified sediments. Sheets of Pliocene - Holocene sediments (5-0 Ma) of up to 60 km wide are located in and adjacent to present drainage lines. The South-west Border region is dominated by vast, late Pleistocene dunefields.

Outcropping units in the Surat Basin youngs eastwards, from the early Jurassic (205-195 Ma) Precipice Sandstone in an arc from Taroom to Barcaldine, to the mid-Cretaceous Griman Creek Formation southeast of Surat. Paleocene-Eocene sediments are scattered over the Cretaceous units, notably the Wallumbilla Formation in the vicinity of the Warrego Highway. The Cretaceous strata are also largely obscured by Pliocene-Holocene sediments.

Small areas of remnant Oligocene-Miocene (30-20 Ma) basalt are located in the Roma and Amby-Injune areas, north of Taroom (Gwambegwine) and near Alpha. These basalts are outliers of the extensive basalt sheets in the Central Highlands and in south-east Queensland, west to Dalby. Pliocene-Pleistocene (5-2 Ma) flow basalts extend eastwards from the upper Burdekin River area into the Richmond-Hughenden area.

5 Geological History Post Late Mesozoic

Early Cretaceous (135-100 Ma)

During this time a large marine transgression flooded much of Western Queensland, commencing from near Cape York, and then extending south and west to cover the western half of the State, as well as significant areas of New South Wales, South Australia and the Northern Territory. Large quantities (over 1500m) of fine to medium grained sediments (predominantly sandstones, siltstones and shales) were deposited with some significant but thin limestone (Toolebuc Formation). Although some of the sandstones deposited during this period were quartz sandstones, the majority were lithic, ie composed of sand-size grains which consisted of fragments of then pre-existing rocks. Generally these source rocks were andesitic volcanics. These rocks now form the aquaclude of the Great Artesian Basin.

Mid Cretaceous (100-80 Ma)

A marine regression then occurred due to vertical earth movements (upwarping and faulting), resulting in a change in the depositional environment from marine to fresh water conditions. This upwarping was a result of tectonism to the east, which also resulted in the emplacement of intrusive and extrusive volcanics and the deposition of sediments in a number of basins along coastal Queensland. At this time the continent was located well south of its current position and weather conditions tended to be much colder and wetter than at present. The rate of deposition progressively reduced and a stable period commenced.

Late Cretaceous - Early Paleocene (80-60 Ma)

This was a period of deep weathering, the formation of lateritic profiles and the development of silcretes and ferricretes (Morney Profile). Drainage was essentially to the southwest.

Late Paleocene - Eocene (60-40 Ma)

Extensive continental deposition occurred, resulting in the Eyre Formation in the southwest and the Karumba Basin in and around the Gulf of Carpentaria. Some north-trending drainage began to develop. Extensive sedimentation was also occurring in other areas of Queensland during this time, both onshore and offshore.

Early Oligocene (40-30 Ma)

This was another period of intense, deep weathering over most of the State, similar to that which occurred during late Cretaceous - Paleocene time. Ferricrete and silcrete development resulted in the Aurukun Surface in the north, the Tennant Creek Surface in the west, the Cordillo Surface in the southwest, the Canaway Profile in the south and the "Upper Erosion Surface" in the east.

Late Oligocene - Miocene (30-5 Ma)

The first 10 million years or so was a period of earth movement (warping) and volcanism. Extensive basalt flows flooded the Central Highlands and Southeast Queensland, including the eastern Darling Downs. Offshore sedimentation recommenced. Subsequent to this volcanism, deposition of limestones and clastic sediments commenced in the far west. Drainage was again established to the south-southwest and north.

Pliocene - Early Pleistocene (5-1 Ma)

This was a period of intense weathering in the areas adjacent to the Gulf of Carpentaria (Kendall Surface) and alternating erosion, sedimentation and silicification in the western areas. Drainage continued essentially in similar directions as during the Miocene. Extensive basaltic volcanism was also occurring in the northeast, in the upper Burdekin area.

Late Pleistocene - Holocene (1-0 Ma)

During this time extensive sand dunes formed on the western plains. Established drainage patterns persisted. The influence of the Ice Ages was fundamentally different here than in the Northern Hemisphere where extensive ice sheets formed. Because of these ice sheets, sea water levels dropped dramatically, and a more arid climate prevailed in Western Queensland.

Geological Data Availability

Geological maps at a scale of 1:250 000 are available for the entire State, while selected areas are covered by maps at 1: 100 000. A full State map, at a scale of 1:2 500 000 is also available. Geological mapping is also available in digital format and has been interfaced with the Department's GIS. Copies of this digital map have been included on one of the CDs which accompany this note. Copies of most mapping can be obtained through the relevant Regional Geologists. Table 1 summarises the broad aspects of the geology of Western Queensland.

6 Geomorphology (Landform)

The geological history previously described provides the basis of the geomorphology of the western part of the State. Six broad geomorphic areas can be defined in the west: Dissected ancient ridges, Rolling Downs, Tertiary rises, Tertiary volcanics, alluvial plains, sand dunes. In terms of area, the Rolling Downs constitutes the largest geomorphic unit, with alluvial plains, sand dunes, and Tertiary rises constituting other areally significant units. The other two units (Tertiary volcanics, and dissected ancient hills) do not occupy significant areas, except in some localised areas where they are the dominant units.

Rolling Downs

The Great Artesian Basin is a huge basin structure consisting of deeply weathered Cretaceous sediments which have generally been only slightly deformed by gentle down-warping. This strata outcrops in the central west as gently undulating "Rolling Downs". The unit is characterised by gently undulating terrain with a wave length of 1 to 2km and an amplitude of approximately 5m.

Tertiary Rises

Dissected areas of younger sediments overlie the Cretaceous rocks, often outcropping as well-defined linear ridge lines of alluvial sandstones. These areas often parallel the existing drainage paths (e.g. the Diamantina and Thompson systems) along whose banks extensive ancient river deposits occur (e.g. the Leander Ridge). Elsewhere, Tertiary duricrusts have allowed the formation of extensive mesas. In some areas, broad low plains of often fine-grained siliceous sediments occur (e.g. the Eyre Formation south of Boulia). The linear tertiary ridges generally are less than 20m high and may extend for typically 20km to 50km. Mesa structures, capped by tertiary sediments are typically 30m high and confined to localised areas containing a number of such structures.

Alluvial Plains

Alluvial plains occur in two forms either broad alluvial plains, or as long, relatively narrow, infill plains associated with the current drainage system. Two vast alluvial plains can be defined, a northern and a southern plain. The northern plain extends from north of the Flinders Highway to the Gulf of Carpentaria, with the plain thickening northwards. The southern plain extends from south of the Warrego Highway and extends many hundred of km into New South Wales. This plain thickens towards the south. Both plains are generally underlaid by deeply weathered sediments of the Rolling Downs Group. The second form of the alluvial plains consists of much smaller alluvial infills along the existing drainage channels.

Both types of alluvial plains are characterised by very flat topography and contain similar surface "black soils". Unlike the Rolling Downs "black soils" which grade to completely weathered rock, these are characterised by a distinct textural change with depth, with sands commonly underlying the surface black soil. These sands then rest on the weathered rocks of the Rolling Downs Group. These sand deposits may be sources of subartesian water.

Sand Ridges

In the southwest corner of the State extensive development of aeolian (wind blown) sand deposits have formed as parallel dune fields. These dunes overlie either the older tertiary deposits or the weathered rocks of the Rolling Downs Group.

Drainage

Drainage lines feature gradients of generally less than 0.02%. Watercourses have highly variable flow regimes and muddy sediment loads, although some (aeolian and fluvial) sand can be found in the waterholes. Two distinct channel patterns are

evident: well-defined anatomising channels which interconnect wider and deeper water holes (characteristic of low energy conditions); and braided channels (characteristic of high energy conditions). Conventional braided channels contain coarse sand bed load (e.g. Cloncurry River). South-western streams are unusual in that the bed load is comprised of sand-sized pellets of mud.

Geomorphological Data Availability

Geomorphological maps at a scale of 1:1 000 000 are available for most of the State, while selected areas are covered by maps at scales to 1: 100 000. This mapping was generally undertaken as part of regional land system mapping of the State. The available digital geomorphological mapping has been interfaced with the Department's GIS. Copies of these digital maps have been included on one of the CDs which accompany this note. Unlike the Soils and Geology CDs, the Land System CD contains the data as one of a number of individual maps based on project areas. Furthermore there is no coverage of the far north west (west of Mt Isa), or of a section extending along parts of the Queensland/New South Wales border. Copies of the notes which accompany this mapping are available via relevant Regional Geologists. This mapping maps the State into various land systems. A land system is a compilation based on the underlying geology, surface soil, topography, and vegetation cover of an area. A land system may be further divided into Land Units. While the digital mapping contains details of the land system, details of the individual land units are only available in the reports accompanying the mapping, as detailed in the Bibliography of this note.

7 Road-making Materials

Thirteen classes of road making material sources are defined in WQ33. These sources are described therein in geological terms and age of formation.

The potential geological sources for some of these rocks are shown in the attached maps. When perusing these maps it must be realised that the geology of only the western two-thirds of the State has been shown, although in some cases incomplete sections of the eastern areas will also appear. Table 2 contains a tabulation of these materials in terms of their geological and geomorphological expression.

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9 Author

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10 Appendix

The following tables and maps are included in the appendix.

Table 1. Summary of Geological History.

Table 2. Summary of Materials Sources.

Map 1. Queensland Geology.

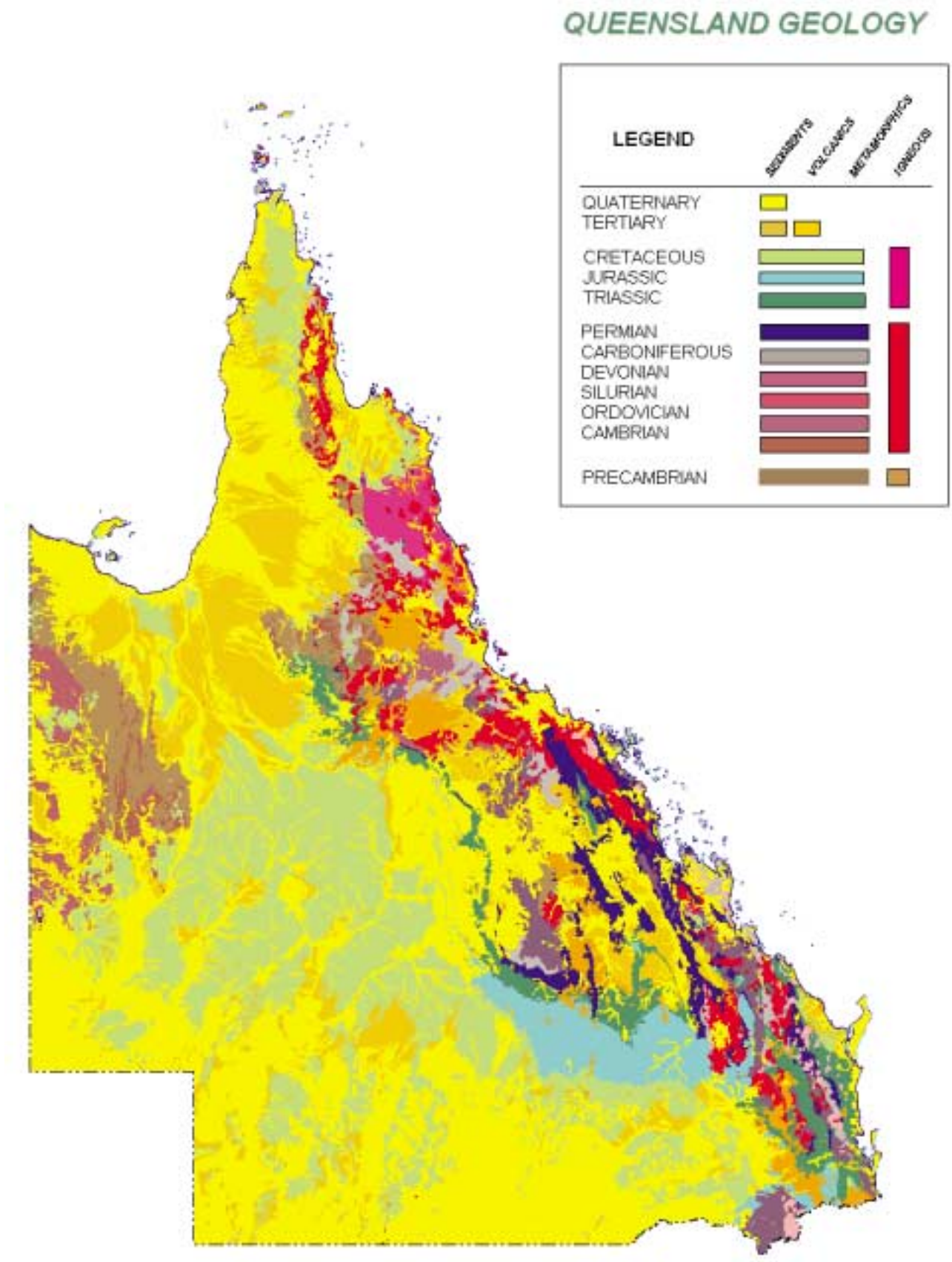
Era	Period	Epoch	Approx. Age (Ma)	Characteristic Activity in Western Queensland
CAINOZOIC	Quaternary	Holocene	0-0.01	Soil development.
		Pleistocene	0.01-2	Sand dune development. Drainage to south- southwest.
	Late Tertiary	Pliocene	2-5	Sedimentation and deep weathering. Drainage to south.
		Miocene	5-30	Uplift, basalts along eastern margins. Drainage to southwest and north.
	Early Tertiary	Oligocene	30-40	Deep weathering, laterite, silcrete, ferricrete.
		Eocene	40-55	Extensive continental sedimentation, drainage to north and southwest.
		Paleocene	55-65	Deep weathering, laterite, silcrete and ferricrete profiles. Drainage to south-west.
MESOZOIC	Cretaceous	Upper*	65-80	
		Middle*	80-100	Extensive continental sedimentation.
		Lower*	100-135	"Albian" marine transgression, extensive marine sedimentation.
	Jurassic		135-205	Onset of cratonic sedimentation: continental sediments in Great Artesian Basin area.
	Triassic		205- 230	Not significant in the west.
PALAEOZOIC	Permian, Carboniferous, Devonian, Silurian.		230 - 440	Not significant in the west.
	Ordovician, Cambrian		440 - 605	Formation of sedimentary rocks west of the Mt Isa Inlier.
PRECAMBRIAN			>605	Formation of sedimentary, metamorphic and igneous rocks in the Mt Isa and Georgetown Inliers areas.

* The Cretaceous is formally split into two epochs; in this area a three-part division is considered more applicable.

Table 1 Summary of Geological History

Geological unit	Geomorphologic unit	Material	Road making materials	Typical Sources
Quaternary Alluvium, Rolling Downs Group	Alluvial plains Rolling Downs	Black Soil	Black soil	Ubiquitous
Pleistocene	Sand Ridges	Desert loams	Desert loams	Numerous loam pits
Quaternary Alluvium	Alluvial plains	Alluvial gravels	Generally poorly graded gravels	Wockingham channels
Quaternary	Plains	Gidgee	Potential source of aggregates and gabion rock	Common
Tertiary Basalts	Tertiary volcanics	Tertiary Basalts	Traditional quarried products	Barabon E of Hughenden, Amby E of Mitchell
Glendower Formation, Duricrust, Laterite	Tertiary rises	Duricrust	Source silcrete rock	Kynuna quarry
Tertiary Sediments	Tertiary rises	Ridge gravels	Generally poorly graded gravels	Leander ridge NW of Longreach
Tertiary Sediments	Tertiary rises	White rock	Generally low strength rock	Tatoo
Rolling Downs Group	Rolling Downs	Sandstone	Soft weathered clayey sandstone	Mt Landsborough SE of Winton.
Rolling Downs Group	Rolling Downs	Mudrock	Soft weathered clayey shale/ siltstone/mudstone	Stanford area
Toolebuc Limestone	Rolling Downs	Soft Limestones	Soft shaley limestone	St Elmo's pit
Various	Complex ridges	Ancient rocks	Potential quarry sources	Tertiary rises
Various generally in ancient terrain	Various	Mine Waste	Potential source of crushed rock	

Table 2 Summary of Materials Sources



Map 1 Queensland Geology