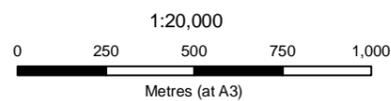


1	Mrs Anne Frost
2	Mr John Forrest
3	Mrs Anne Frost
4	Mr Mark Rodden & Ms Sharon Tein
5	Mrs Carolyn Larcombe
6	Mr Cornel & Mrs Hiroe Swen
7	Mr Lawrence Heffernan



LEGEND	
	Site Boundary
	Option 1B
	Crown Land
	Rinker (Quarry)
	Robin Pty Ltd
	Tuggeranong Investments
	Village Building Company



Queanbeyan City Council  
Dunn's Creek

Job Number | 22-12266  
Revision | A  
Date | 5 Dec 2007

### Option 1B and Property Boundaries

Figure F1



Appendix H  
Geotechnical Report

DRAFT



## Desktop Study

Prior to the geotechnical assessment being undertaken, six possible road alignments had been identified by GHD in consultation with Council. Ecological constraint mapping conducted by GHD then identified a number of sensitive areas to be avoided in the southern parts of the study area. Only the two most northern alignments were capable of avoiding these sensitive environmental areas.

This report presents the findings of a desktop study and walk over inspection of the northern alignment corridor to identify the likely geological conditions that will prevail at the site, geotechnical constraints that should be considered and the likely geotechnical investigations that will be required for design of the proposed road.

The desktop study included a review of topographic, geological and soil landscape maps for the study area. Each of these data sources are summarised below.

## Topography

The fixed western portion of the alignment finishes on a ridgeline at about RL 700 metres AHD. Immediately east of the ridgeline the two northern most alignments descend into a steep gully and cross Jerrabomberra creek at about RL 650 metres AHD. Over the final 3 kilometres, both northern alignments climb and cross a ridgeline either side of a knoll at about 800 metres AHD.

## Soil Landscapes

A review of the 1:100,000 scale Soil Landscape Series Sheet for Canberra (2000) indicates that the study area is underlain by four soil landscape units. At the time of this assessment, the northern most alignment (yellow alignment) was the preferred option. This alignment traverses the following soil landscape units:

- |                         |                   |
|-------------------------|-------------------|
| ▶ Chainage 0 to 800     | Williamsdale (wi) |
| ▶ Chainage 800 to 2800  | Luxor (lub)       |
| ▶ Chainage 2800 to 4800 | Burra (ba)        |
| ▶ Chainage 4800 to 6400 | Campbell (ca)     |
| ▶ Chainage 6400 to end  | Burra (ba)        |

Following a review of the 1:100,000 scale Soil Landscape Series Sheet for Canberra (2000) a summary has been prepared in Table G1. The distribution of the soil landscape units is shown in Figure G1 and typical cross sections for the Williamsdale, Burra and Campbell soil landscape units are shown in Figures G2, G3 and G4 respectively.

## Geology

A review of the 1:50,000 scale geological map for Canberra, Queanbeyan and Environs (1980) indicates that the western half of the alignment is underlain by the Deakin Volcanics which generally comprise:

- ▶ Green-grey, purple and cream rhyolite, agglomerate, purple tuff, tuffaceous sandstone, rhyodacite and rhyodacitic crystal tuff (Sud5);
- ▶ Red-purple and green-grey rhyodacite (Sud6); and
- ▶ Cream rhyolite (Sud10).



The eastern half of the alignment is underlain by the Colinton Volcanics, typically comprising:

- ▶ Foliated dacite and tuff, minor siltstone and shale lenses.

The distribution of the two geological units is shown on Figure G5.

### **Walk Over Site Inspection**

An experienced engineering geologist conducted a site walk-over on 30 October 2007. The site walkover was used to confirm the findings of the desktop study, identify any geotechnical constraints and identify possible geotechnical investigations that may be required. The walk-over covered the section of Dunn's Creek Road corridor between Jerrabomberra Creek and Old Cooma Road along the alignments of Options 1A and 1B.

### **Geology and Soils**

The walkover inspection generally confirmed the nature and distribution of soil landscape and geological units as identified by the desktop study.

The eastern end of the alignment (east of the central ridgeline) was dominated by foliated dacite as shown in Photograph G1. Areas of residual soil showed evidence of erodibility as indicated in the desktop study (Photograph G2). The dacite outcrops were typically observed to be medium strong and highly weathered.

The following rock mass defects were observed in the dacite:

- ▶ Near vertical foliation, striking between 210 and 240 degrees, typically 0.05 to 0.1m spacing;
- ▶ Near vertical joints, striking between 135 to 175 degrees, typically 0.5 to 1.0m spacing; and
- ▶ Moderately dipping joints, dipping west, typically spaced 0.05 to 0.2 metres apart.

The western end of the alignment was typically underlain by rhyodacite as indicated by the desktop study. Less rock outcrop was observed along the western half of the alignment. Those areas of rock outcrop appeared to have similar rock mass defects as described for the eastern parts of the alignment.

Large areas of steep colluvial soils were observed along the western parts of the alignment (Photograph G5). The areas of colluvial soils were typically characterised by hummocky ground.

### **Geotechnical Constraints**

As discussed above, the two northernmost alignments traverse steep topography, including a deep gully and creek crossing followed by a 150 metre increase in elevation over about 1.5 kilometres. This steep topography is expected to result in deep cuttings and fill embankments to satisfy standard road design grade requirements.

### **Cuttings**

Cuttings are expected to encounter residual and colluvial soils (those soils that have moved downslope due to gravity) overlying a weathered igneous bedrock profile. The depth of soil is expected to vary considerably along the alignment.

East of the central ridgeline rock was observed to be at or near the existing ground surface (Photograph G1). The depth to rock is expected to be deeper west of the ridgeline where colluvial soil masses were observed along much of the alignment.



The soil profile (in particular the colluvial soil profile) will need to be carefully addressed in the future cutting designs. These materials will likely require significantly lower batter angles than the underlying rock to maintain long term stability.

The incorporation of crestal drainage into the batter design will be critical to ensure that catchment water from above the cutting cannot flow over the cutting crest, destabilising these soil materials.

The degree of weathering and the strength of the underlying rock are expected to generally improve with depth. The stability of the rock excavations is expected to be controlled by the nature and orientation of the rock mass defects (joints and foliations).

One of the prominent rock mass defects observed during the site walkover was a steeply dipping foliation, striking in a north-east direction. For the sections of road that trend in a north-east direction these foliation defects will be parallel to the rock batter face. Near vertical defects of this nature will typically lead to toppling failure of the rock cutting. Block failures may generally be quite small (<0.2m diameter) but larger block failures are likely. Likewise, joints that were observed to have a moderate dip towards the west could lead to sliding failure of the cutting rock mass where the road alignment trends in a north-south direction.

Each the rock mass defects naturally occurring at the site have the potential to create instability and resulting safety hazards if not identified and addressed in the design. The cutting design should carefully consider the rock mass conditions, and incorporate appropriate avoidance, stabilisation or failure protection measures. These may include the adoption of appropriate batter angles, benches, use of rock bolts and shotcrete to stabilise unstable masses or seams, rock fall catch zones at the toe of the cutting and rock fall protection fencing. The appropriate design elements should be identified during a detailed geotechnical investigation.

### ***Fill Embankments***

It is expected that deep fill embankments will be required to infill deep gully crossings along the alignment. Consideration will need to be given to the existing foundation conditions and how much material may need to be stripped prior to construction of engineered fill above. This is particularly the case where deep colluvial soils are present along the alignment.

It is expected that the rock materials extracted from cuttings will provide material that is suitable for use as engineered fill. This will need to be confirmed by field investigations and laboratory testing of materials.

### **Geotechnical Investigations Required**

Geotechnical investigations will be required to enable the road design to be completed. Investigations are likely to include a combination of test pits and boreholes.

For a road of this nature, test pits would typically be excavated every 100 metres along the road alignment. The test pits would typically be excavated using a small excavator to a maximum depth of about 5 metres.

Boreholes would be used more selectively (due to the increased cost of investigation) to target bridge locations, deep cuttings and any other critical areas of the alignment. Inclined boreholes may be required for some of the deeper cuttings to enable the extracted rock core to be oriented and the rock mass defect orientations measured.



The geotechnical investigation report will be required to provide the factual results of the investigation and comments / recommendations on:

- ▶ The expected subsurface conditions along the alignment;
- ▶ Excavatability of the encountered materials;
- ▶ Re-use of excavated materials for engineered fill;
- ▶ Appropriate batter angles for the various materials;
- ▶ Soil and rock slope instability risk mitigation measures;
- ▶ Embankment foundation conditions and preparation;
- ▶ Serviceability bearing pressures for bridge structures;
- ▶ Groundwater conditions; and
- ▶ Other geotechnical issues that may impact on construction time and cost.

#### **Conclusion**

GHD would be pleased to provide any further services that may be required in relation to the geotechnical issues raised in this brief assessment.

#### **References**

1. Jenkins, B.R. 2000, Soil Landscapes of the Canberra 1:100,000 Sheet, Department of Land and Water Conservation, Sydney.
2. Geology of Canberra, Queanbeyan and Environs. Bureau of Mineral Resources, Geology and Geophysics, Department of National Development and Energy. 1980.

Table G1 Summary of Soil Landscape and Geological Units

Soil Landscape	Geology	Landscape	Land Degradation	Included Soil Landscapes	Landscape Limitations	Soils	Erodibility			
							Layer	Non-concentrated flows	Concentrated flows	Wind flows
Williamsdale (Transferral) <u>Chainage</u> 0 - 800	Silurian volcanics including Colinton volcanics and the Cappanana Formation. Various tuffs with minor siltstone, shale, sandstone and limestone. Alluvial material is common. Bedrock tends to be highly weathered.	Undulating rises, fans, valley flats and depressions on Silurian on Silurian Volcanics of the Canberra lowlands. Includes significant areas of pediplain. Local relief 5 – 50 m, elevation 550 – 650 m; waning footslopes (<10%). Little or no rock outcrop. The original woodland has been cleared. Grass areas have been extensively altered.	Minor gully erosion is common and widespread.	Often Burra soil landscape grades into Williamsdale and some overlap is inevitable.	<ul style="list-style-type: none"> <li>▶ Seasonal waterlogging;</li> <li>▶ Complex terrain;</li> <li>▶ Flood hazard (localised);</li> <li>▶ Run-on;</li> <li>▶ Dieback.</li> </ul>	<p><b>Type Profile 1 – Lower Slope</b></p> <p><b>Layer 1, A<sub>1</sub>: 0 – 8 cm</b> wi1 Greyish yellow brown loam.</p> <p><b>Layer 2, A<sub>2</sub>: 8 – 16 cm</b> wi2 Dull yellow orange silty loam.</p> <p><b>Layer 3, B<sub>2</sub>: 16 – 58 cm</b> wi3 Bright yellowish brown light clay.</p> <p><b>Type Profile 2 – Lower Slope</b></p> <p><b>Layer 1, A<sub>1</sub>: 0 – 15 cm</b> wi1 Brownish black loam.</p> <p><b>Layer 2, A<sub>2c</sub>: 15 – 27 cm</b> wi4 Dull yellow brown silty loam.</p> <p><b>Layer 3, B<sub>2</sub>: 27 – 90 cm</b> wi5 Yellowish brown light-medium clay.</p> <p><b>Type Profile 3 – Low Rises</b></p> <p><b>Layer 1, A<sub>1</sub>: 0 – 8 cm</b> wi6 Dark reddish brown clay loam.</p> <p><b>Layer 2, B<sub>2</sub>: 8 – 16 cm</b> wi7 Dark red light-medium clay.</p>	Layer	Non-concentrated flows	Concentrated flows	Wind flows
							Wi1	Moderate	High	Mod - High
							Wi2	Moderate	High	High – V High
							Wi3	Moderate	High	Low - Mod
							Wi4	High	High	Mod - High
							Wi5	Very High	High	Low - Mod
							Wi6	Moderate	High	Very Low
							Wi7	High	High	Very Low
Luxor – Landscape variant <u>lub</u> (Transferral) <u>Chainage</u> 800 - 2800	Colluvium – poorly cemented conglomerate and fan deposits, gravel and sand. It is thought that the colluvial deposits are a relict feature, having been formed under colder periglacial conditions	Waning lower slope fans with slopes <20% and often 10%. Local relief is up to 30 m at 630 – 670 m elevation. Drainage is sluggish. There are no rock outcrops, although some surface rock and exposed pans are occasionally evident.	Little or no erosion.	The colluvial deposits that comprise the Luxor (lu) soil landscape are draped over what would otherwise be the Burra (ba), Williamsdale (wi) and Ginninderra Creek (gc) soil landscapes. Small areas of these landscapes (which are too small to map at the 1:100,000 scale) occur as ridges and folds within areas marked as luxor (lu) soil landscape. Some overlaps between Luxor (lu) soil landscape and Burra (ba), Williamsdale (wi) and Ginninderra Creek (gc) soil landscapes occurs at the lower margins of Luxor (lu) soil landscape, where the colluvial deposits are thinnest.	<ul style="list-style-type: none"> <li>▶ Complex terrain (localised);</li> <li>▶ Mass movement hazard;</li> <li>▶ Run-on (localised);</li> <li>▶ Seasonal waterlogging (localised);</li> <li>▶ Sheet erosion risk;</li> <li>▶ Engineering hazard (localised).</li> </ul>	<p><b>Type Profile 1 – Lower Slope</b></p> <p><b>Layer 1, A<sub>1</sub>: 0 – 18 cm</b> Lu1 Brownish black sandy loam.</p> <p><b>Layer 2, A<sub>2</sub>: 18 – 50 cm</b> Lu2 Dull yellowish brown sandy loam.</p> <p><b>Layer 3, B<sub>2</sub>: 50 – 68 cm</b> Lu3 Bright brown light clay.</p> <p><b>Layer 4, B: 68 – 156 cm</b> <b>Massive pan.</b></p> <p><b>Layer 5, 2B<sub>2</sub>: 156 – 190 cm</b> Lu4 Bright yellowish brown light clay.</p>	Layer	Non-concentrated flows	Concentrated flows	Wind flows
							Lu1	Moderate	High	Low
							Lu2	Moderate	Very high	Low
							Lu3	Low	Very high	Low
							Lu4	Very high	Very high	Low

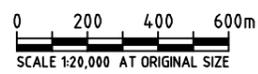
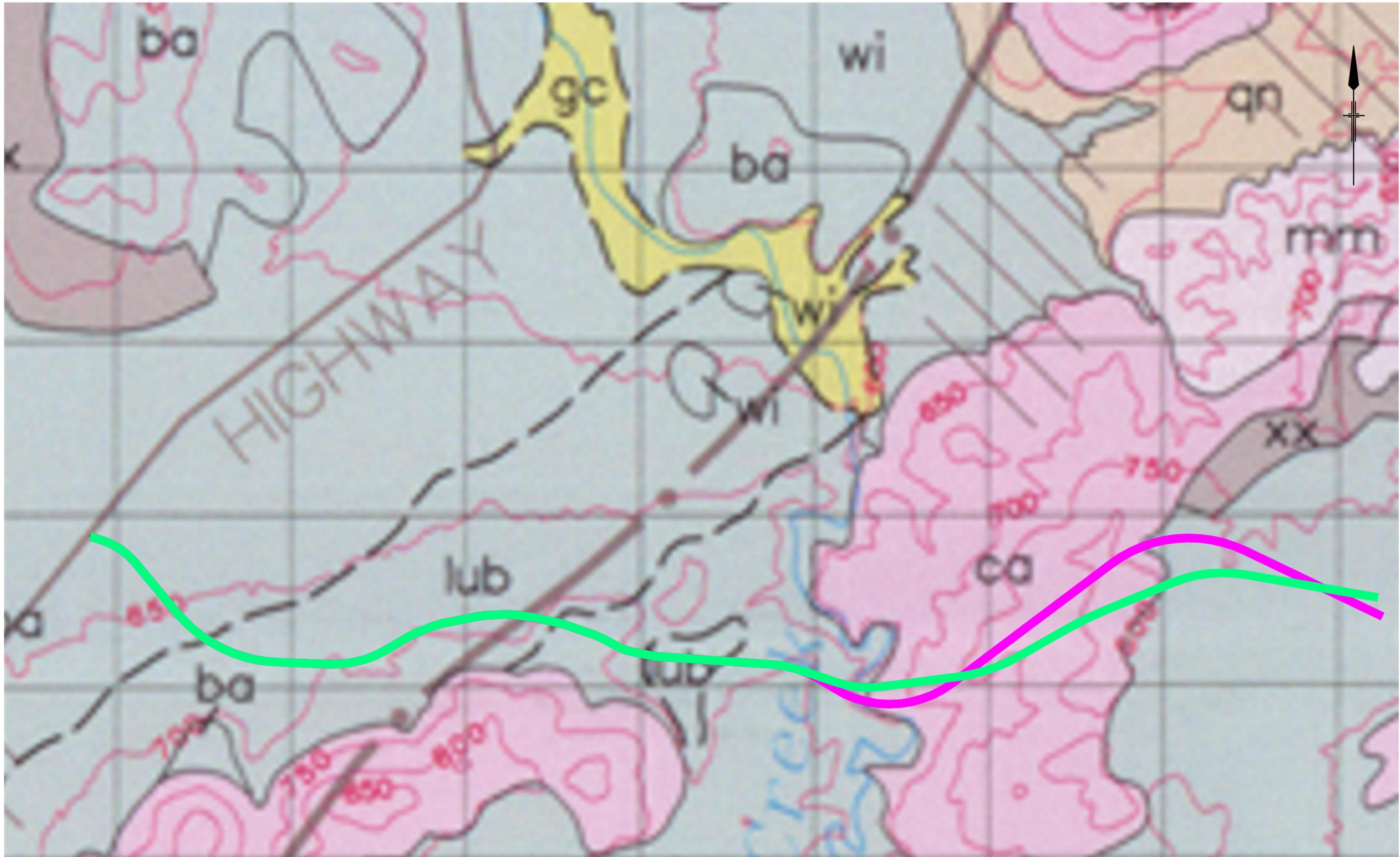


Soil Landscape	Geology	Landscape	Land Degradation	Included Soil Landscapes	Landscape Limitations	Soils	Erodibility			
							Ca1	Moderate	High	Very Low
Campbell (Colluvial) <u>Chainage</u> 4800 - 6400	Silurian volcanics and sediments of the Canberra Block. The complicated lithology includes various tuffs, siltstones, sandstone, rhyolites, dacites and limestones.	Steep to rolling rounded hills and mountains with slopes >20%. Local relief is 100 – 350 m at 600 – 1100 m elevation. Rock outcrop occurs anywhere on slopes often as rows of tombstone-sized and shaped outcrops of near vertically dipping tuff. Crests are rounded and narrow (<100m), whereas hillslopes are long (>300m), often with terracettes and waning colluvial lower slopes. Drainage lines are often degraded. Springs are common on some mid and lower slopes.	Minor and moderate sheet erosion is common and widespread. Mass movement, particularly terracetting, is evident on steep slopes. Gully erosion is common along drainage lines, occasionally severe and <1.5 m deep.	The boundary between Campbell and Burra soil landscapes is often gradual and it is inevitable that some overlap will occur. Burra soil landscape occurs on fans and more gently inclined hillslopes.	<ul style="list-style-type: none"> <li>Steep Slopes;</li> <li>Engineering Hazard;</li> <li>Moderate mass movement hazard;</li> <li>Springs (permanently high watertables);</li> <li>Sheet erosion risk;</li> <li>Shallow soils;</li> <li>Run-on (lower slopes and drainage lines);</li> <li>Rock outcrop.</li> </ul>	<b>Type Profile 1 - Midslope</b> <b>Layer 1, A<sub>1</sub>: 0 – 10 cm</b> <u>Ca1</u> Brownish black loam. <b>Layer 2, A<sub>2</sub>: 10 – 18 cm</b> <u>Ca2</u> Dark brown loam. <b>Layer 3, B<sub>2</sub>: 18 – 48 cm</b> <u>Ca3</u> Dull reddish brown light clay.	Ca1	Moderate	High	Very Low
						<b>Type Profile 2 – Open depression</b> <b>Layer 1, A<sub>1</sub>: 0 – 6 cm</b> <u>Ca1</u> Greyish yellow brown loam. <b>Layer 2, A<sub>2</sub>: 6 – 28 cm</b> <u>Ca2</u> Dull yellow orange sandy clay loam. <b>Layer 3, B<sub>2</sub>: 28 – 120 cm</b> <u>Ca4</u> Bright brown light-medium clay.	Ca2	High	High	Very Low
							Ca3	High	Very High	Very Low
							Ca4	Moderate	High	Low
Burra (Transferral) <u>Chainage</u> 2800 – 4800 and 6400 - end	Silurian volcanics including Colinton volcanics and the Cappanana Formation. Various tuffs with minor siltstone, shale, sandstone and limestone. Bedrock tends to be highly weathered.	Undulating to rolling hills and alluvial fans with generally long (>300 m), gently to moderately inclined waning slopes (5-30%). Local relief is <90 m; elevation 650 – 900 m. Landform elements include hillslopes, footslopes and fans. Localised terracettes are common.	Extensive disturbance and alteration of soil materials, the land surface and drainage networks has taken place in suburban areas. Minor sheet erosion is widespread on rural lands.	The boundary between Campbell and Burra soil landscapes is often gradual and it is inevitable that some overlap will occur. Burra soil landscape occurs on fans and more gently inclined hillslopes	<ul style="list-style-type: none"> <li>Sheet erosion risk;</li> <li>Localised Shallow soils;</li> <li>Localised Run-on;</li> <li>Dieback.</li> </ul>	<b>Type Profile 1 – Upper Slope</b> <b>Layer 1, A<sub>1</sub>: 0 – 8 cm</b> <u>Ba1</u> Dark brown loam. <b>Layer 2, A<sub>2e</sub>: 8 – 28 cm</b> <u>Ba2</u> Dull yellow orange silty loam. <b>Layer 3, B<sub>2</sub>: 28 – 84 cm</b> <u>Ba3</u> Dark reddish brown medium-heavy clay.	Ba1	Moderate	Moderate	Low
						<b>Type Profile 2 – Midslope</b> <b>Layer 1, A<sub>1</sub>: 0 – 6 cm</b> <u>Ba1</u> Brownish black sandy loam. <b>Layer 2, A<sub>2e</sub>: 6 – 28 cm</b> <u>Ba5</u> Dull yellow sandy clay loam. <b>Layer 3, B<sub>2</sub>: 28 – 120 cm</b> <u>Ba4</u> Yellowish brown medium clay. <u>Ba2</u> Dull yellow sandy clay loam. <b>Layer 3: 28 – 120 cm</b> <u>Ba4</u> Yellowish brown medium clay.	Ba2	High	High	Low
							Ba3	High	Moderate	Low
							Ba4	Moderate	Moderate	Low
							Ba5	High	High	Low

Source: Jenkins, B.R. 2000, Soil Landscapes of the Canberra 1:100,000 Sheet, Department of Land and Water Conservation, Sydney.

Notes:

1. Loam is generally defined as a mixture of sand, clay and organic material.
2. Distribution diagrams for each soil landscape type are presented as Figures E1 and E2.
3. Landscape limitations are land related properties that can affect land use. Where these limitations are not widespread throughout the landscape they are referred to as localised.



QUEANBEYAN CITY COUNCIL  
 DUNNS CREEK ROAD ALIGNMENT STUDY  
 SOIL LANDSCAPE MAP

job no. | 23-12266  
 rev no. | A

scale | 1:20000 for A3 date | 6/12/2007

Figure E1

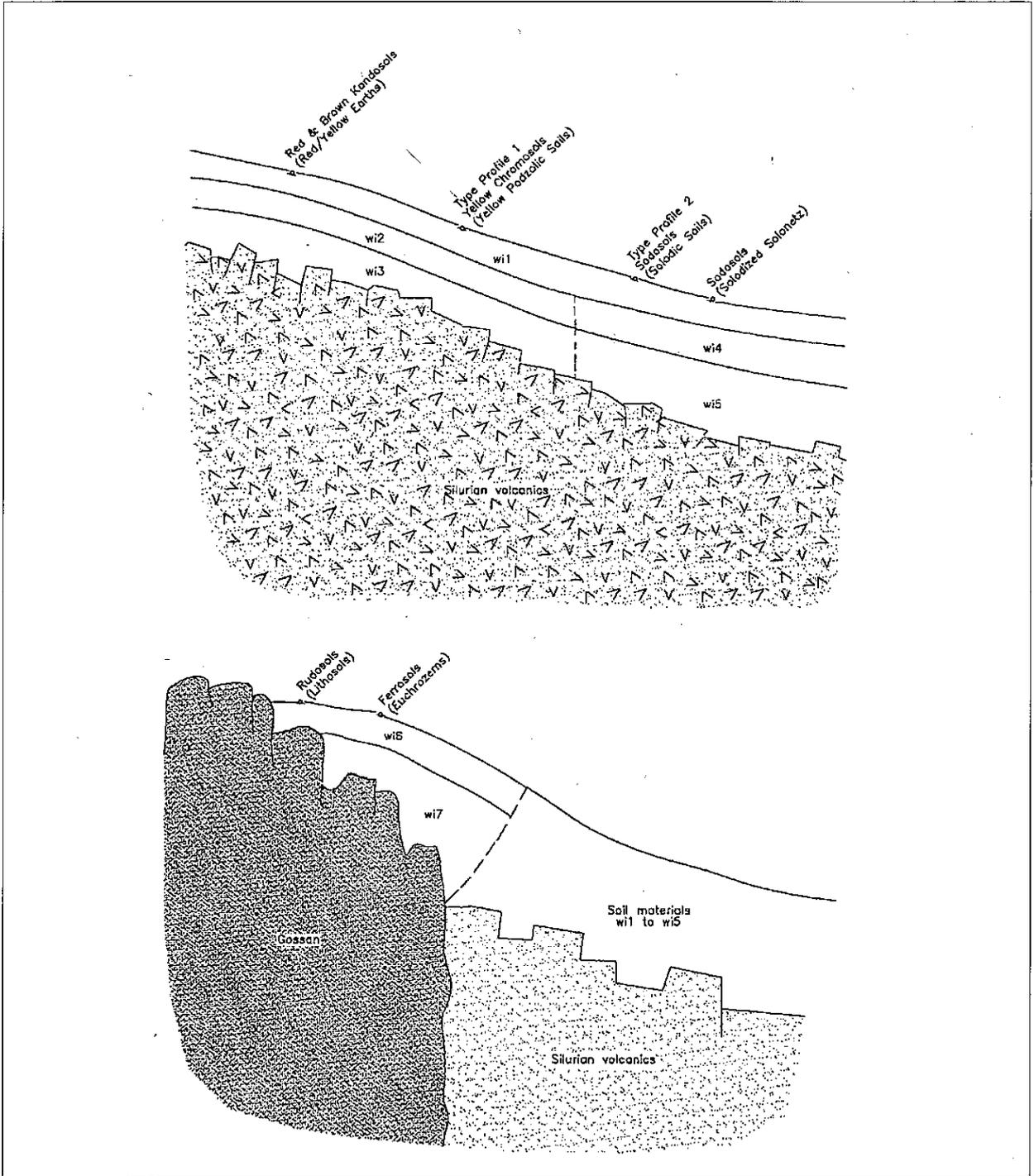
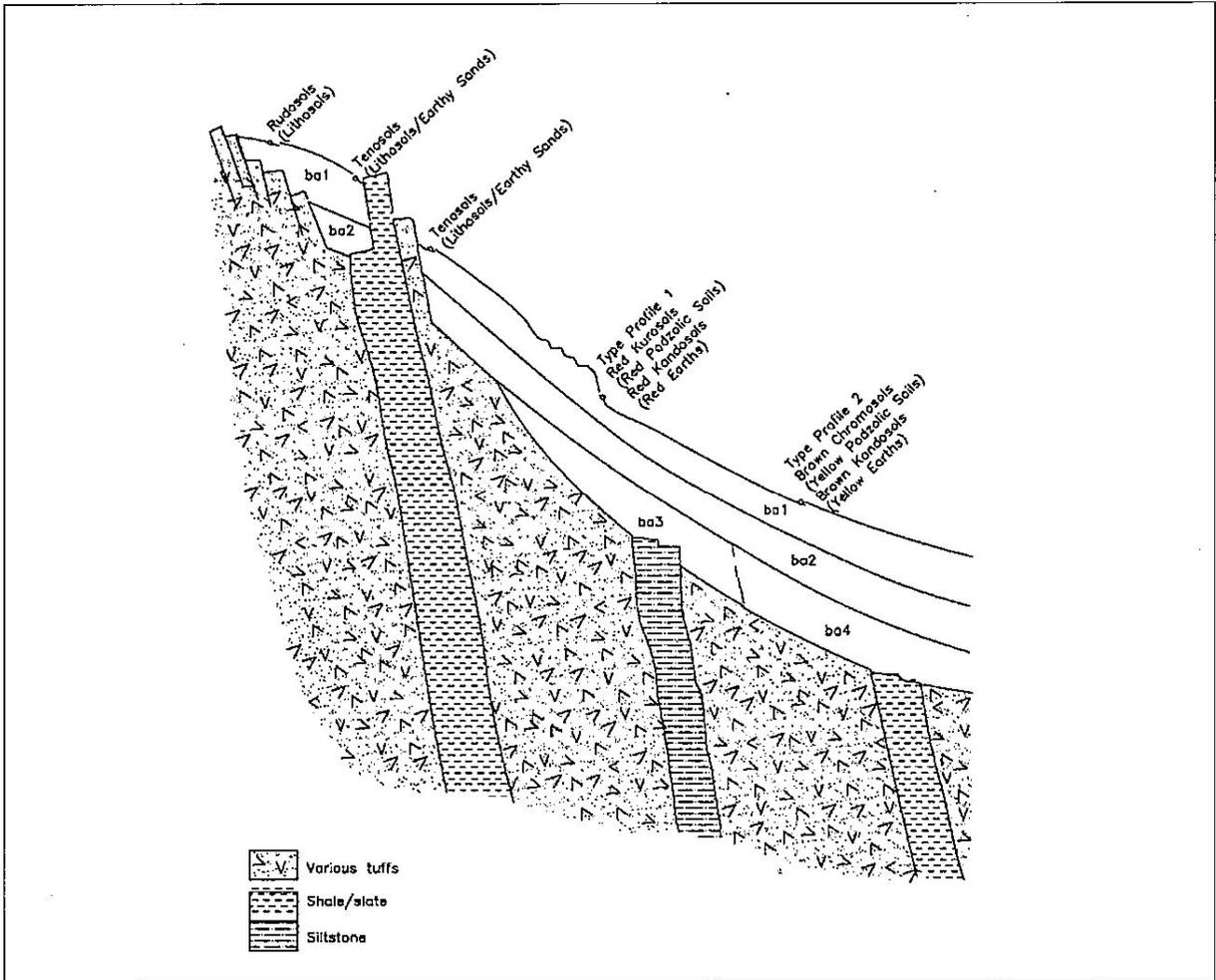
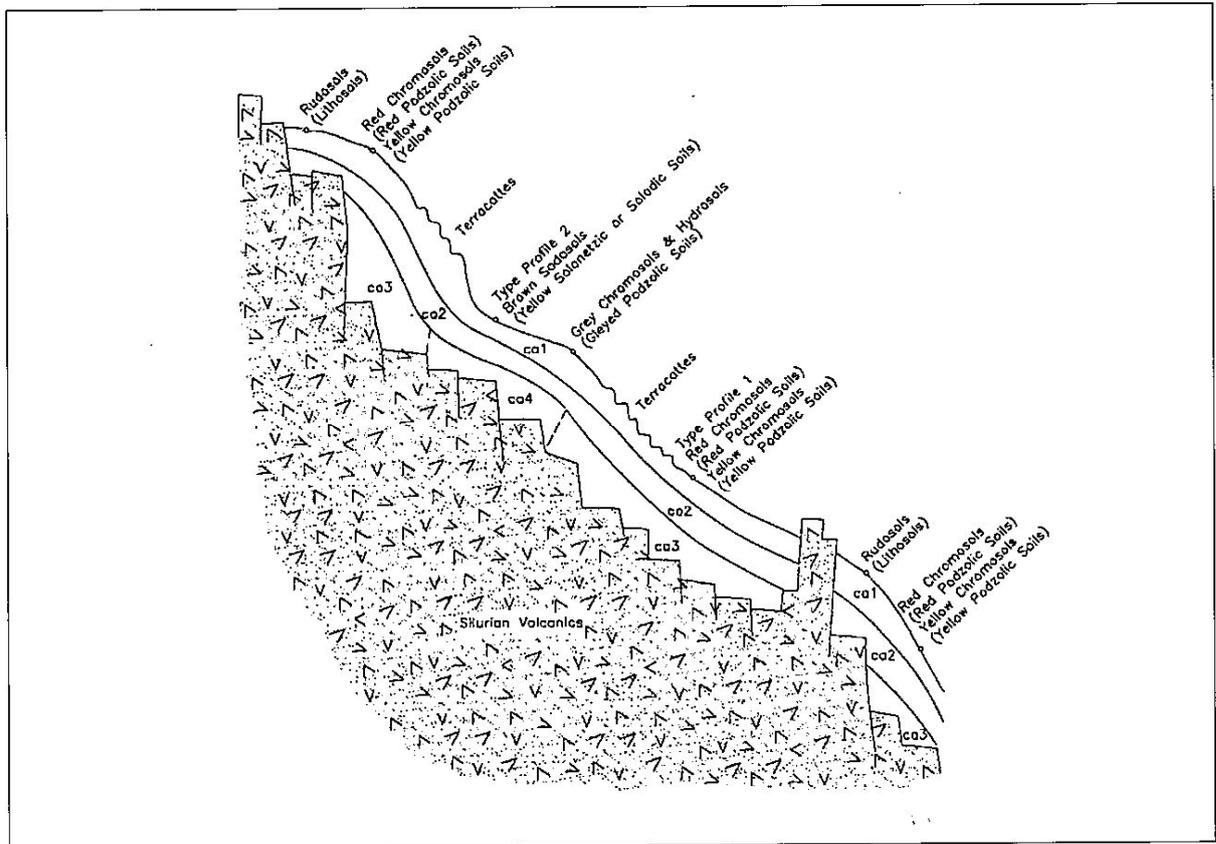


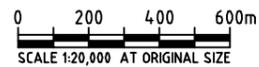
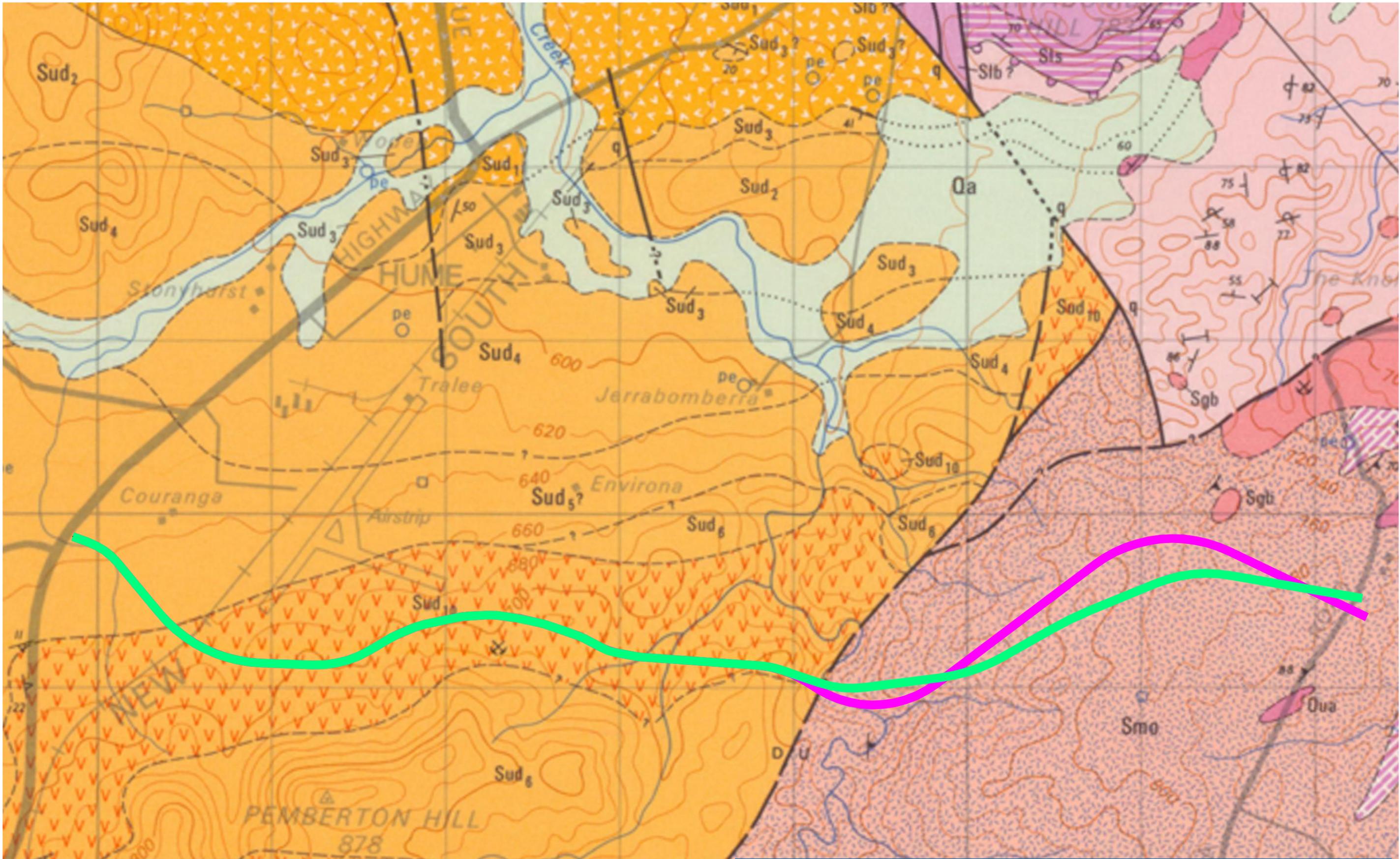
Figure G2 Distribution Diagram of Williamsdale Soil Landscape Illustrating Occurrence and Relationship of Dominant Soil Materials (source: Jenkins, B.R. 2000)



**Figure G3 Distribution Diagram of Burra Soil Landscape Illustrating Occurrence and Relationship of Dominant Soil Materials (source: Jenkins, B.R. 2000)**



**Figure G4** Distribution Diagram of Campbell Soil Landscape Illustrating Occurrence and Relationship of Dominant Soil Materials (source: Jenkins, B.R. 2000)



CLIENTS | PEOPLE | PERFORMANCE

QUEANBEYAN CITY COUNCIL  
 DUNNS CREEK ROAD ALIGNMENT STUDY  
 GEOLOGICAL MAP

job no. | 23-12266  
 rev no. | A

scale | 1:20000 for A3 date | 6/12/2007

Figure E5



**Photograph G1 Rock Outcrop at Eastern End of Northern Alignments**



**Photograph G2 Gully Erosion about 900m West of Old Cooma Road**



**Photograph G3** Central Ridgeline, from Eastern End of Northern Alignment



**Photograph G4** Western Part of Northern Alignment, from Ridgeline



**Photograph G5 Steep Colluvial Soils North of Proposed Creek Crossing**



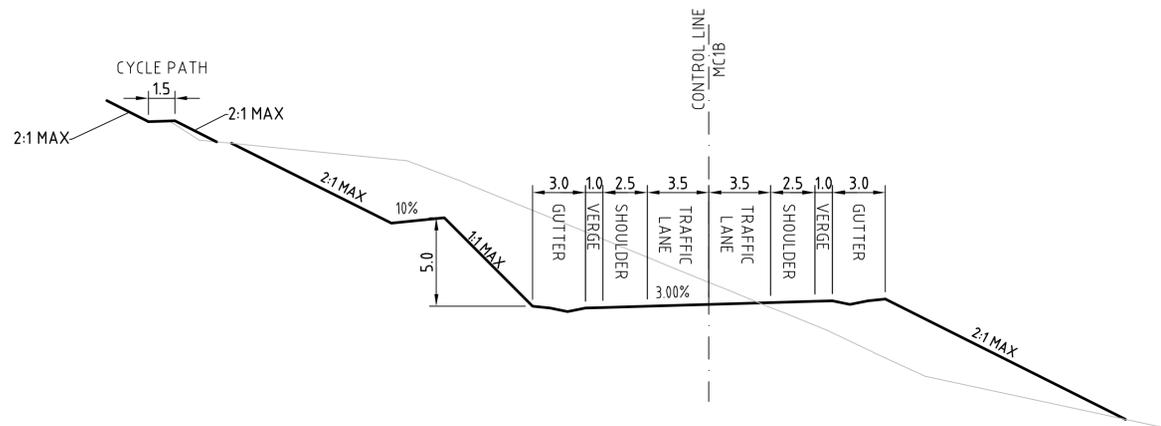
**Photograph G6 Proposed Creek Crossing and Junction with Fixed Portion of Road Alignment**



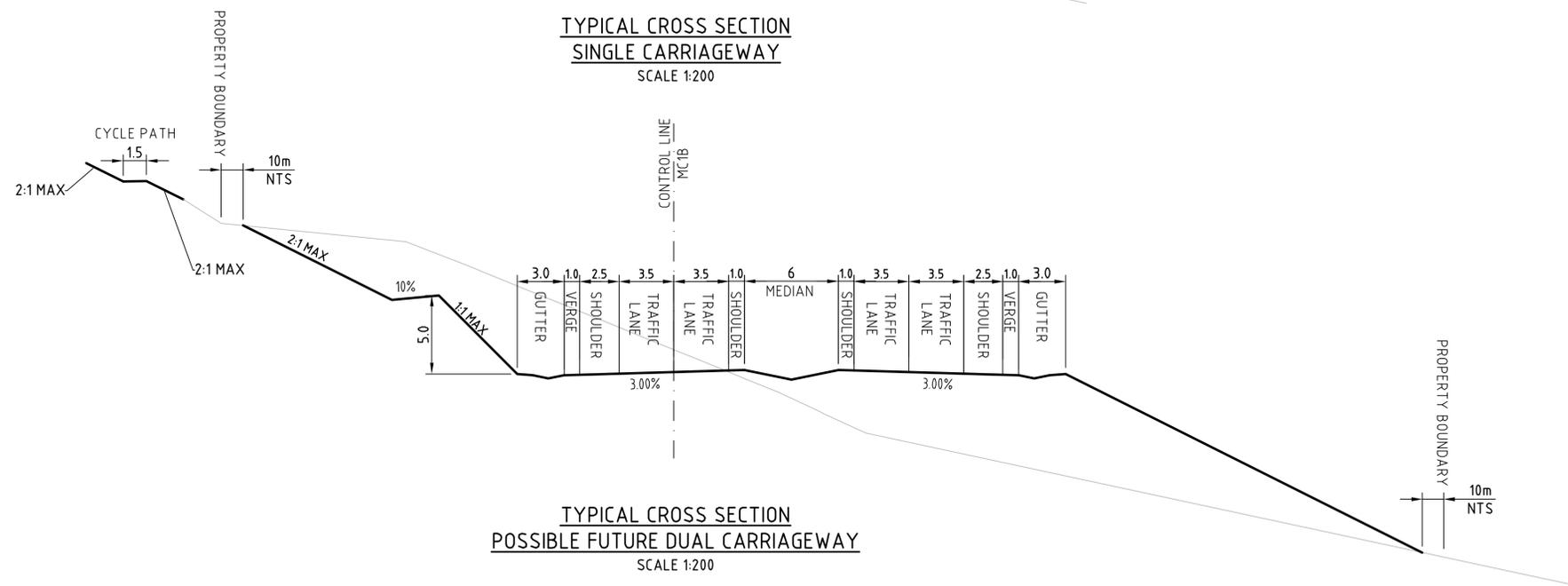
Appendix I

# Preliminary Road Design Drawings

DRAFT



TYPICAL CROSS SECTION  
SINGLE CARRIAGEWAY  
SCALE 1:200



TYPICAL CROSS SECTION  
POSSIBLE FUTURE DUAL CARRIAGEWAY  
SCALE 1:200

PRELIMINARY



**GHD** CLIENTS | PEOPLE | PERFORMANCE

2nd Floor, Belconnen Chambers  
59 Cameron Ave Belconnen ACT 2617 Australia  
PO Box 36 Belconnen ACT 2617  
T 61 2 6253 1999 F 61 2 6253 1911  
E cbmail@ghd.com.au W www.ghd.com.au

**DO NOT SCALE**

Conditions of Use.  
This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

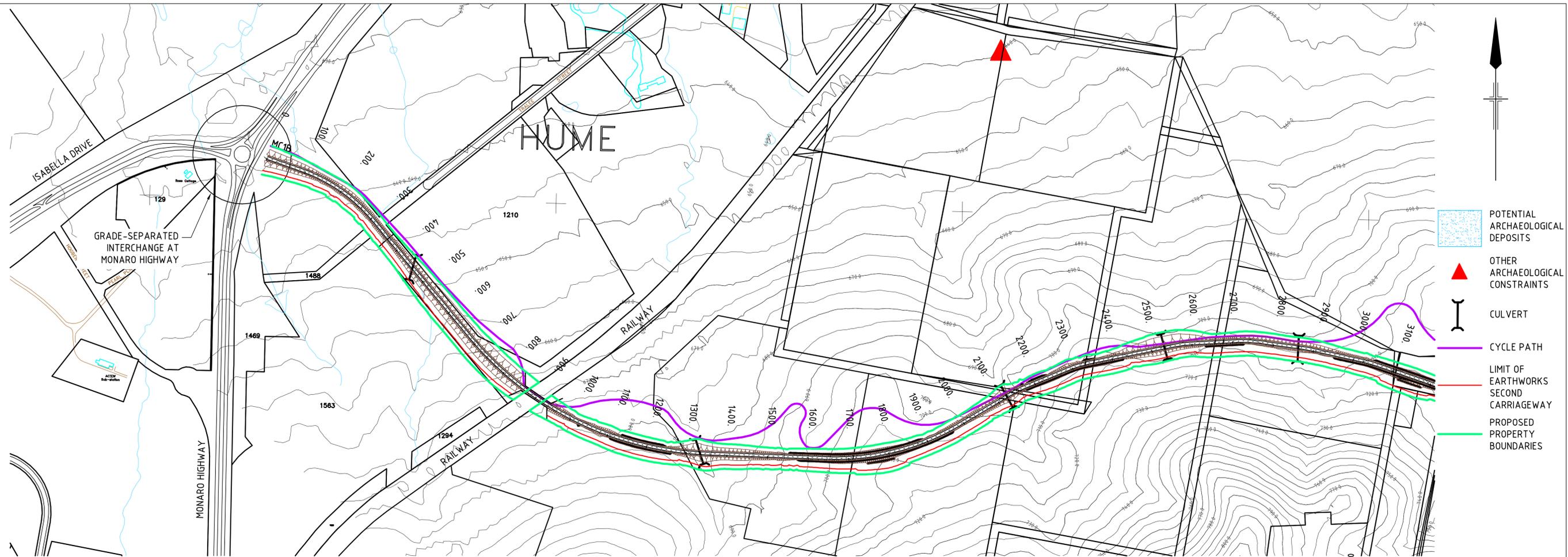
Drawn	T YEATS	Designed	M LYONS
Drafting Check	S.O'KEEFE	Design Check	G.GARDNER
Approved			
Date			
Scale	1:100	This Drawing must not be used for Construction unless signed as Approved	

Client **QUEANBEYAN CITY COUNCIL**  
Project **DUNNS CREEK ROAD ALIGNMENT STUDY**

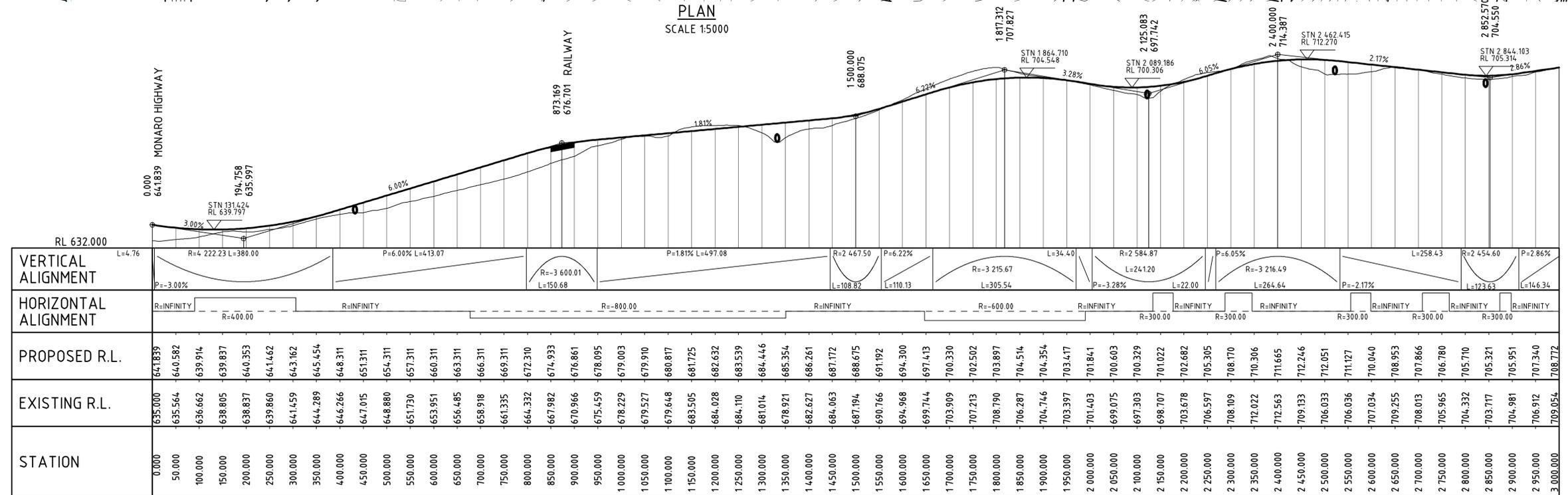
Title **TYPICAL CROSS SECTION**  
Original Size **A1** Drawing No: **23-12266-SK007**

Rev: A

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Checked	Approved	Date
A	PRELIMINARY ISSUE		TY	SOK*	TC*	15.9.08



PLAN  
SCALE 1:5000



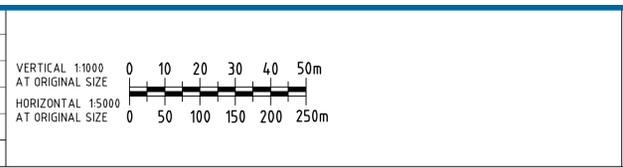
DUNNS CREEK OPTION1B - CONTROL LINE MC1B

HORIZONTAL SCALE 1:5000  
VERTICAL SCALE 1:1000

STATION	EXISTING R.L.	PROPOSED R.L.	HORIZONTAL ALIGNMENT	VERTICAL ALIGNMENT
0.000	635.000	641.839	R=INFINITY	L=4.76
50.000	635.564	640.582	R=400.00	P=-3.00%
100.000	636.662	639.914	R=INFINITY	P=6.00% L=413.07
150.000	638.805	639.837	R=INFINITY	R=-3.600.01 L=150.68
200.000	638.837	640.353	R=800.00	P=1.81% L=497.08
250.000	639.860	641.462	R=INFINITY	R=2.467.50 L=108.82
300.000	641.459	643.162	R=INFINITY	P=6.22%
350.000	644.289	645.454	R=600.00	L=34.40
400.000	646.266	648.311	R=INFINITY	R=2.584.87 L=24.120
450.000	647.015	651.311	R=INFINITY	P=6.05%
500.000	648.880	654.311	R=INFINITY	R=-3.216.49 L=264.64
550.000	651.730	657.311	R=300.00	P=-2.17%
600.000	653.951	660.311	R=INFINITY	L=258.43
650.000	656.485	663.311	R=INFINITY	R=2.454.60 L=123.63
700.000	658.918	666.311	R=INFINITY	P=2.86%
750.000	661.335	669.311	R=300.00	L=146.34
800.000	664.332	672.310	R=INFINITY	
850.000	667.982	674.933	R=INFINITY	
900.000	670.966	676.861	R=INFINITY	
950.000	675.459	678.095	R=INFINITY	
1000.000	678.229	679.003	R=INFINITY	
1050.000	679.527	679.910	R=INFINITY	
1100.000	679.648	680.817	R=INFINITY	
1150.000	683.505	681.725	R=INFINITY	
1200.000	684.028	682.632	R=INFINITY	
1250.000	684.110	683.539	R=INFINITY	
1300.000	681.014	684.446	R=INFINITY	
1350.000	678.921	685.354	R=INFINITY	
1400.000	682.627	686.261	R=INFINITY	
1450.000	684.063	687.172	R=INFINITY	
1500.000	687.194	688.675	R=INFINITY	
1550.000	690.766	691.192	R=INFINITY	
1600.000	694.968	694.300	R=INFINITY	
1650.000	699.744	697.413	R=INFINITY	
1700.000	703.909	700.330	R=INFINITY	
1750.000	707.213	702.502	R=INFINITY	
1800.000	708.790	703.897	R=INFINITY	
1850.000	706.287	704.514	R=INFINITY	
1900.000	704.746	704.354	R=INFINITY	
1950.000	703.397	703.417	R=INFINITY	
2000.000	701.403	701.841	R=INFINITY	
2050.000	699.075	700.603	R=INFINITY	
2100.000	697.303	700.329	R=INFINITY	
2150.000	698.707	701.022	R=INFINITY	
2200.000	703.678	702.682	R=INFINITY	
2250.000	706.597	705.305	R=INFINITY	
2300.000	708.109	708.170	R=INFINITY	
2350.000	712.022	710.306	R=INFINITY	
2400.000	712.563	711.665	R=INFINITY	
2450.000	709.133	712.246	R=INFINITY	
2500.000	706.033	712.051	R=INFINITY	
2550.000	706.036	711.127	R=INFINITY	
2600.000	707.034	710.040	R=INFINITY	
2650.000	709.255	708.953	R=INFINITY	
2700.000	708.013	707.866	R=INFINITY	
2750.000	705.965	706.780	R=INFINITY	
2800.000	704.332	705.710	R=INFINITY	
2850.000	703.717	705.321	R=INFINITY	
2900.000	704.981	705.951	R=INFINITY	
2950.000	706.912	707.340	R=INFINITY	
3000.000	709.054	708.772	R=INFINITY	

PRELIMINARY

No	Revision	Note	Drawn	Checked	Approved	Date
A	PRELIMINARY ISSUE		MW	SOK*	TC*	15.9.08



**GHD** CLIENTS | PEOPLE | PERFORMANCE

2nd Floor, Belconnen Chambers  
55 Cameron Ave Belconnen ACT 2617 Australia  
PO Box 36 Belconnen ACT 2617  
T 61 2 6253 1999 F 61 2 6253 1911  
E cbrmail@ghd.com.au W www.ghd.com.au

**DO NOT SCALE**

Conditions of Use:  
This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

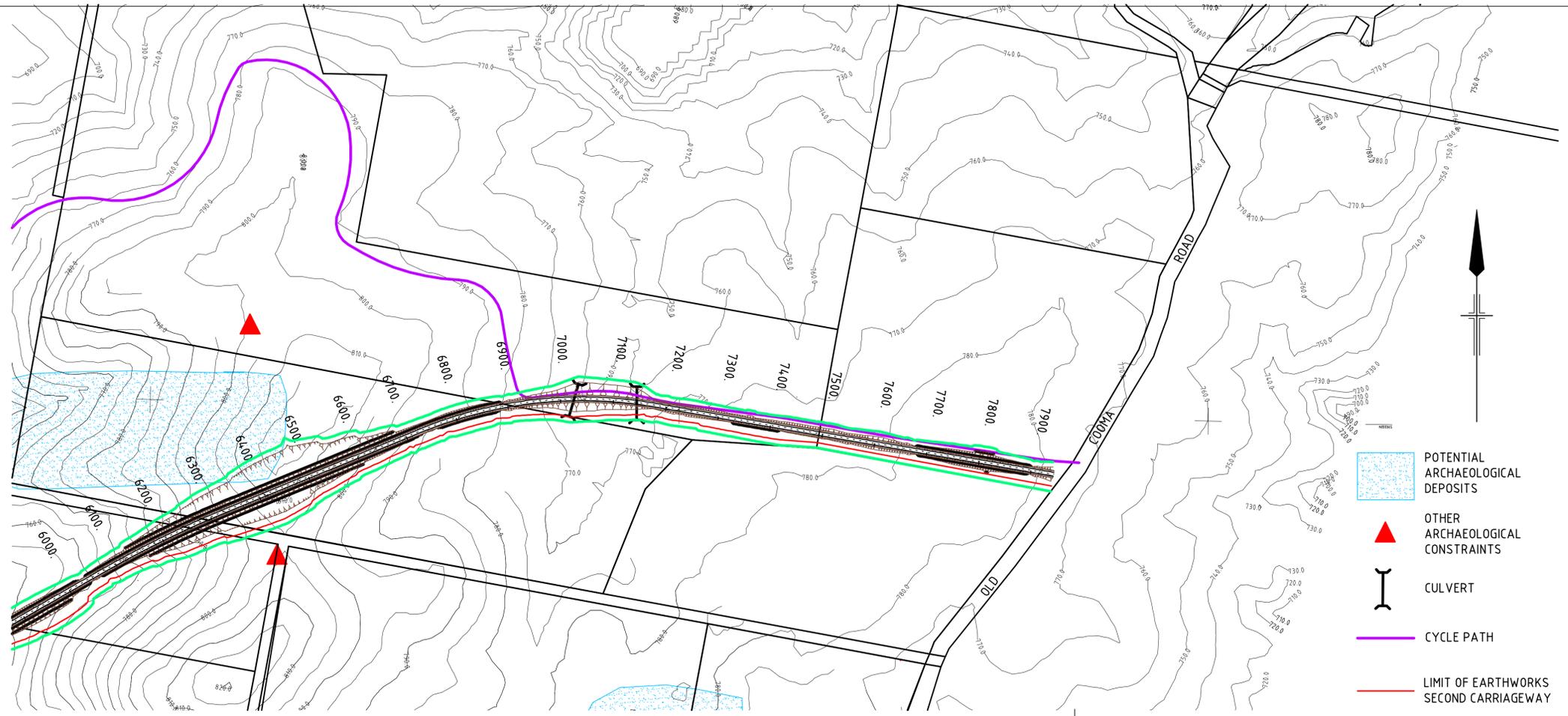
Drawn M.WATSON  
Designed M.LYONS  
Drafting Check S.O'KEEFE  
Design Check G.GARDNER  
Approved  
Date  
Scale AS SHOWN

This Drawing must not be used for Construction unless signed as Approved

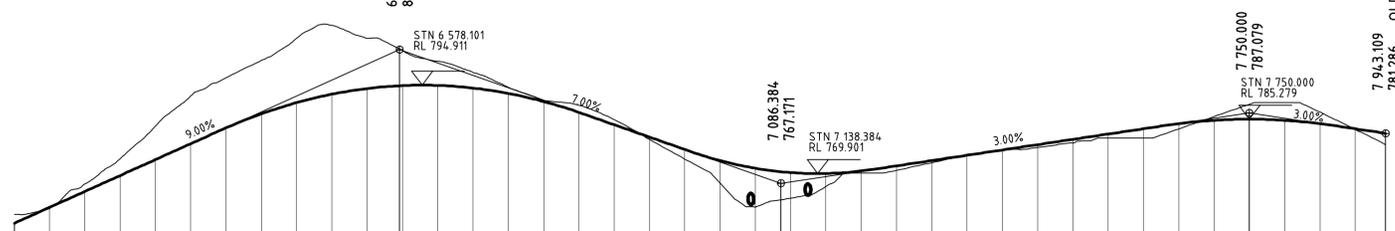
Client **QUEANBEYAN CITY COUNCIL**  
Project **DUNNS CREEK ROAD ALIGNMENT STUDY**  
Title **OPTION 1B  
PLAN AND PROFILE - SHEET 1 OF 3**

Original Size **A1**  
Drawing No: **23-12266-SK009**  
Rev: **A**





PLAN  
SCALE 1:5000



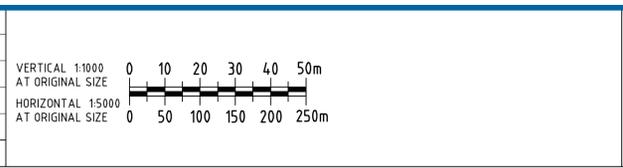
VERTICAL ALIGNMENT	P=9.00%	L=1 053.89	R=-3 200.00 L=512.00	P=-7.00%	L=154.28	R=2 600.00 L=260.00	P=3.00% L=413.62	R=-3 999.99 L=240.00	P=-3.00%	L=73.11																													
HORIZONTAL ALIGNMENT	R=INFINITY	R=2 000.00	R=INFINITY	R=800.00	R=INFINITY	R=INFINITY	R=INFINITY	R=INFINITY	R=INFINITY	R=INFINITY																													
PROPOSED R.L.	755.841	760.341	764.841	769.341	773.841	778.341	782.826	786.781	789.954	792.346	793.957	794.787	794.836	794.103	792.589	790.293	787.217	783.718	780.218	776.718	773.583	771.403	770.184	769.927	770.631	772.079	773.579	775.079	776.579	778.079	779.579	781.079	782.579	784.029	784.967	785.279	784.967	784.029	782.579
EXISTING R.L.	758.422	759.984	766.950	774.118	783.300	791.834	797.005	801.869	808.119	811.834	808.123	804.718	801.678	798.526	794.318	790.618	789.203	785.171	779.555	774.043	767.247	760.453	762.945	766.230	770.000	770.822	772.977	775.069	776.479	777.259	778.587	780.000	780.000	782.544	786.026	789.508	790.000	787.280	782.404
STATION	6 000.000	6 050.000	6 100.000	6 150.000	6 200.000	6 250.000	6 300.000	6 350.000	6 400.000	6 450.000	6 500.000	6 550.000	6 600.000	6 650.000	6 700.000	6 750.000	6 800.000	6 850.000	6 900.000	6 950.000	7 000.000	7 050.000	7 100.000	7 150.000	7 200.000	7 250.000	7 300.000	7 350.000	7 400.000	7 450.000	7 500.000	7 550.000	7 600.000	7 650.000	7 700.000	7 750.000	7 800.000	7 850.000	7 900.000

DUNNS CREEK OPTION1B - CONTROL LINE MC1B

HORIZONTAL SCALE 1:5000  
VERTICAL SCALE 1:1000

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Checked	Approved	Date
A	PRELIMINARY ISSUE		MW	SOK*	TC*	15.9.08



**GHD** CLIENTS | PEOPLE | PERFORMANCE

2nd Floor, Belconnen Chambers  
55 Cameron Ave Belconnen ACT 2617 Australia  
PO Box 36 Belconnen ACT 2617  
T 61 2 6253 1999 F 61 2 6253 1911  
E cbmail@ghd.com.au W www.ghd.com.au

**DO NOT SCALE**

Conditions of Use.  
This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Drawn M.WATSON  
Designed M.LYONS  
Drafting Check S.O'KEEFE  
Design Check G.GARDNER  
Approved  
Date  
Scale AS SHOWN

This Drawing must not be used for Construction unless signed as Approved

Client **QUEANBEYAN CITY COUNCIL**  
Project **DUNNS CREEK ROAD ALIGNMENT STUDY**  
Title **OPTION 1B  
PLAN AND PROFILE - SHEET 3 OF 3**

Original Size **A1**  
Drawing No: **23-12266-SK011**  
Rev: **A**



DRAFT

**GHD Pty Ltd** ABN 39 008 488 373

59 Cameron Avenue Belconnen ACT 2617

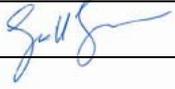
PO Box 36 Belconnen ACT 2616 Australia

T: 61 2 6253 1999 F: 61 2 6253 1911 E: cbrmail@ghd.com.au

© **GHD Pty Ltd 2008**

This document is and shall remain the property of GHD Pty Ltd. The document may only be used for the purposes for which it was commissioned and in accordance with the Consultancy Agreement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

**Document Status**

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Draft	M Lyons	G Gardner		T Chapman		15/09/08

# Appendix D – Queanbeyan City Council Report for Dunns Creek Road Alignment Study Flora and Fauna Constraints of Option 1B and Option 5, July 2009



CLIENTS | PEOPLE | PERFORMANCE

## **Queanbeyan City Council**

### **Report for Dunns Creek Road Alignment Study**

**Flora and Fauna Constraints of  
Option 1B and Option 5**

July 2009



# Contents

Report Definitions and Abbreviations	1
1. Introduction	4
1.1 Scope of Work	4
1.2 Requirements of Queanbeyan City Council	4
1.3 Department of Environment and Climate Change Consultation	5
2. Methods	8
2.1 Desktop Assessment Using Previous Studies	8
2.2 Field Surveys for Flora and Ecological Communities	9
2.3 Field Surveys for Fauna	11
3. Results	17
3.1 Weather Conditions	17
3.2 Flora and Ecological Communities	17
3.3 Fauna	22
4. Likelihood of Threatened Species and Communities Occurring in the Study Area	33
5. Constraints	46
5.1 Flora and Ecological Communities	46
5.2 Fauna	47
6. Potential Offsetting and Recommendations	58
6.1 Recommendations	61
7. Conclusion	63
8. References	64



## Table Index

Table 1	Summary of Survey Effort for Flora and Ecological Communities Within the Study Area	9
Table 2	EPBC Box Gum Woodland listing criteria	10
Table 3	Confidence Ratings Applied to Calls	15
Table 4	Summary of Survey Effort for Fauna and Invertebrates Within the Study Area	16
Table 5	Weather Conditions at the Canberra Airport During Dunn's Creek Rd Surveys	17
Table 6	Targeted Threatened Reptile Species Surveys for the Dunn's Creek Road Proposal	25
Table 7	Anabat Analysis Results	30
Table 8	Survey effort and Locations of Golden Sun Moth Surveys within the Proposed Dunn's Creek Road Study Area	32
Table 9	Threatened Flora Species Recorded Within the Study Area	33
Table 10	Threatened Fauna Species Previously Recorded in the Locality	35
Table 11	Area (ha) of Ecological Communities Likely to be Removed by Each Alignment Option Proposed for Dunn's Creek Road	46
Table 12	Area (ha) of Known and Potential Pink-tailed Worm-lizard habitat Within the Study Area of Each Alignment Route for Dunn's Creek Road	47
Table 13	Summary of known and potential constraints for the proposed Dunn's Creek Road	52
Table 14	Potential Offset Areas Required (Hectares) Under Various Ratios Scenarios	61

## Figure Index

Figure 1	Proposed Route Options for Development of Dunn's Creek Road: Option 1B and Option 5	7
Figure 2	Locations of Flora and Fauna Surveys along the Dunn's Creek Road Route Options	13
Figure 3	Threatened Ecological Communities and their Occurrence within the Option 1B and Option 5 Alignment Routes	19
Figure 4	Threatened Species Records from the Current (Circles) and Previous (Triangles) Survey Periods	21



Figure 5	<i>Aprasia parapulchella</i> Found in the Alignment Route (left) and the Habitat Rock under which it was found (right)	23
Figure 6	Locations of Pink-tailed Worm-lizard and Known and Potential Habitat in the Current Survey Period (N.B. some observations have multiple records)	24
Figure 7	Vegetation Condition Along the Common Route, Option 1B and Option 5	59
Figure 8	Screen Dump of Red Lights in the BioMetric Tool	60

## Appendices

- A DECC Correspondence
- B Flora Lists
- C Fauna List
- D DECC Threatened Species Records



## Report Definitions and Abbreviations

- ▶ *Activity* - for the purpose of this assessment the Activity is the proposed Dunns Creek Road including the Common Route, Option 1b and Option 5 as described in Section 1.
- ▶ AoS - refers to a TSC Act, Part 5A Assessment of Significance (7 part test).
- ▶ DECC – refers to the NSW Department of Environment and Climate Change formally the Department of Environment and Conservation.
- ▶ *Development* - the use of land, the subdivision of land, the erection of a building, the carrying out of a work, the demolition of a building or work and any other matter referred to in S26 of the Act and which is controlled by an environmental planning instrument.
- ▶ DGR's – refers to Director General's Requirements issued by Department of Environment and Climate Change for a potential Species Impact Statement.
- ▶ *Direct impacts* - are those that directly affect habitat and individuals, usually within the footprint of the proposal. They include, but are not limited to, clearing and habitat removal (DEC 2005).
- ▶ DPI – refers to the NSW Department of Primary Industries.
- ▶ EP&A Act – refers to the NSW Environmental Planning and Assessment Act 1979.
- ▶ EPBC Act – refers to the Commonwealth Environment Protection & Biodiversity Conservation Act, 1999.
- ▶ FM Act – refers to the NSW *Fisheries Management Act 1994* administered by the NSW Department of Primary industries.
- ▶ *Indirect impacts* - occur when project-related activities affect resources in a manner other than a direct loss of the resource. Indirect impact may include but are not limited to: killing the species through starvation, exposure, predation by domestic and/or feral animals, loss of breeding opportunities, shade/shelter, increased soil salinity, promotion of erosion, provision of suitable seed bed for exotic weed invasion, or increased human activity within or directly adjacent to sensitive habitat areas (DEC 2005).
- ▶ KTP – refers to a Key Threatening Process listed under the NSW *Threatened Species Conservation Act 1995*.
- ▶ *Life cycle* - is the series of stages of reproduction, growth, development, aging and death of an organism.
- ▶ *Locality* - is an area within a 10 kilometre radius of the subject site as described in Section 1.3.3.
- ▶ *Local occurrence* - means the ecological community that occurs within the study area.
- ▶ *Local population* - is the population that occurs in the study area.
  - Local population of resident fauna comprises those individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas that are known or likely to occur in the study area from time to time.
  - Local population of threatened plant species comprises those individuals occurring in the study area or the cluster of individuals that extend into habitat adjoining and contiguous with the study area that could reasonably be expected to be cross-pollinating with those in the study area.



- ▶ *Proposal* - is the development, activity or action proposed as described in Section 1.
- ▶ QCC – refers to the Queanbeyan City Council.
- ▶ *Risk of extinction* - is the likelihood that the local population of the species or local occurrence of the endangered population or ecological community will become extinct either in the short term, medium term or long-term as a result of direct or indirect impacts on the viability of that population and includes changes to the ecological function of communities.
- ▶ SIS – refers to a Species Impact Statement.
- ▶ *Study area* - is the subject site and any additional areas that are likely to be affected by the proposal, either directly or indirectly. In this instance, a radius of 500 metres from the centreline of each of the alignment routes of the subject site as described in Section 1.3.2.
- ▶ *Subject site* - is the area directly affected by the proposal. The subject site includes a 100m buffer around the centreline of each alignment route as described in Section 1.3.1.
- ▶ TSC Act - refers to the New South Wales Threatened Species Conservation Act 1995.
- ▶ *Viable* – is the capacity to successfully complete each stage of the life cycle under normal conditions.



### **Disclaimer – Must be Read Before Interpreting Report**

This report has been commissioned to assess the potential ecological constraints and identify ecological matters that are likely to require further investigations during the approval and development phases of the proposed Dunn's Creek Road.

This report is prepared as a constraints analysis and not a fully comprehensive impact assessment. It is meant to inform the Queanbeyan City Council (not adjoining landholders or owners of land through which the alignments pass) of the known and potential constraints of each route in the study area.

The survey and report was not designed to provide full floristic composition of each alignment route or to identify all threatened fauna along the proposed alignment route or wider locality. The survey identifies *potential* and *known* habitat for threatened species based on current and previous surveys and assesses the likelihood of additional threatened species that are likely to occur in the study area (not subject site) but were not recorded during the current survey period.

In addition, the purpose of the report is not to identify alternative alignment routes in areas that are ecologically constrained, only to identify where these constraints occur. Identifying alternative alignment routes was beyond the scope of commissioned works for this project and should occur during later stages of the project when the final alignment route is being selected.

The likelihood of occurrence assessment is based on the study area *not* the subject site. The study area includes the subject site and surrounding land within a 500m radius of the subject site (see Figure 1 and report definitions); hence some species are recorded as likely based on known records in the study area not the subject site.



# 1. Introduction

GHD was commissioned by Queanbeyan City Council (QCC) to undertake the Corridor Study and alignment planning phase of Dunn's Creek Road from Monaro Highway to Old Cooma Road, including a comparative environmental constraints assessment for the route options of the proposed development.

The development is being completed in response to anticipated increasing traffic movements between newly released land developments. Queanbeyan City Council and the NSW Government are examining the funding of approximately 8.3 kilometres of road construction for Dunn's Creek Road to provide an additional access link between 'Tralee' (Monaro Highway) and 'Googong' (Old Cooma Road) as part of the overall road network for the southern area of Queanbeyan.

## 1.1 Scope of Work

This report has been commissioned to assess the potential ecological constraints and identify ecological matters that are likely to require further investigations during the approval and development phases. Two preliminary route options have been assessed; Option 1b and Option 5 in the east of the study area, as well as the Common Route which links both Option 1b and Option 5 to the west of the study area (Figure 1).

It should be strongly noted that this report is prepared as a constraints analysis and not a fully comprehensive impact assessment. It is meant to inform the QCC (not adjoining landholders or owners of land through which the alignments pass) of the known and potential constraints of each route.

This report has been prepared to inform Queanbeyan City Council of the ecological issues relating to the two proposed route options for Dunn's Creek Road, determined during field investigations completed along the proposed routes in October and December 2008. The survey and report was not designed to provide full floristic composition of the site or to identify all threatened fauna along the proposed alignment route or wider locality. The survey identifies *potential* and *known* habitat for threatened species based on current and previous surveys and assesses the likelihood of additional threatened species that are likely to occur but were not recorded during the current survey period.

In addition, the purpose of the report is not to identify alternative alignment routes in areas that are ecologically constrained, only to identify where these constraints occur. Identifying alternative alignment routes was beyond the scope of commissioned works for this project and should occur during later stages of the project when alignment route are being more seriously considered (rather than a 100m corridor).

## 1.2 Requirements of Queanbeyan City Council

Queanbeyan City Council requires an ecological constraints assessment to be completed of two route options, Option 1b and Option 5, for the proposed Dunn's Creek Road (Figure 1). Queanbeyan City Council requires advice of ecological matters that are likely to be relevant to the proposed development, with quantification of the likely impact where possible (e.g. area of an Endangered Ecological Community (EEC) likely to be removed).



### **1.3 Department of Environment and Climate Change Consultation**

Advice was sought from the NSW Department of Environment and Climate Change (DECC) by QCC about the proposed road development (Appendix A). Part of the correspondence from DECC included consultation with the engaged consultant. GHD met with DECC officers (Alison Treweek, Michael Hood and Reiner Rehwinkle) on 28 October 2008, to discuss the alignment routes and potential survey effort. As a result of this meeting GHD were advised of a number of issues:

- ▶ Survey area should be limited to an approximate 100m corridor on each alignment for direct impacts;
- ▶ In its current form, this proposed road alignment will almost certainly require a Species Impact Statement (SIS);
- ▶ Survey effort across all species is not completely necessary during this project as specific targeted survey effort would likely be required for the proposed SIS. DECC will administer the guidelines for survey (subject species) in the SIS during issue of the Director Generals Requirements;
- ▶ DECC's preferred option for the proposed Dunns Creek Road should be further to the south where conservation issues are unlikely to be as great as they are in the current alignment route; and
- ▶ DECC are able to run the BioBanking methods for the proposed alignment outré once the route is selected and surveyed.

As a result of this meeting with DECC, GHD conducted two survey periods (as outlined in the original proposal to QCC) and have conducted preliminary indicative offsetting requirements based on a number of scenarios (in the absence of a selected and surveyed final alignment).

#### **1.3.1 Subject Site**

The proposed road will link the Monaro Highway with the Old Cooma Road in an approximate east west alignment. The subject site is divided into three distinct sections. The Common Route is approximately 4.2 kilometres extending east from an intersection on the Monaro Highway. Towards the centre of the study area the subject site divides into two proposed routes, Option 1B (to the north) is approximately 4.0 kilometres and Option 5 (to the south) is approximately 3.6 kilometres. Both Option 1B and Option 5 continue from the Common Route in an approximate east west direction however Option 1B is located further north than Option 5 (Figure 1).

#### **1.3.2 Study Area**

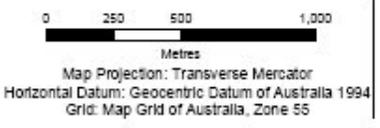
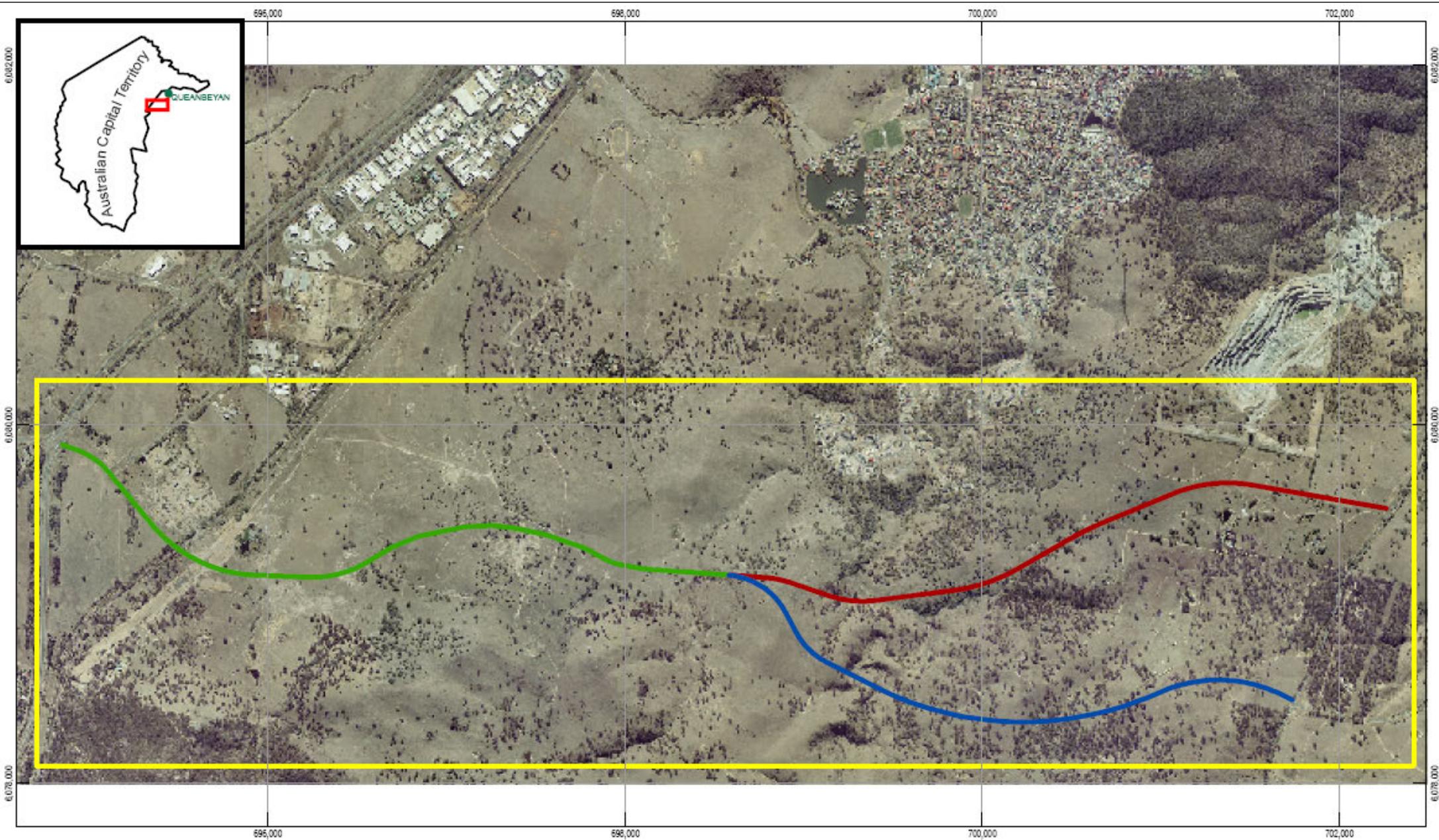
The study area includes the proposed roadways and the surrounding landscape. It includes the proposed road alignment with a 100-metre buffer and nearby vegetation likely to be impacted by the proposed activity. The study area is bound by the industrial suburb of Hume to the west, residential suburb of Jerrabomberra to the north, Googong Dam to the east and rural and rural residential properties to the south. The study area includes a range of vegetation types including Dry Forest Woodland, Box Gum Woodland, Native Grasslands and derived communities. It offers a number of habitats for native species and communities including threatened species and EEC. The study area contains large areas of steep rocky slopes through to more gently undulating areas in the west. The Jerrabomberra Creek runs in a south north direction through the study area. Both Option 1B and Option 5 cross the Jerrabomberra Creek. There are a number of drainage lines throughout the study area; besides the Jerrabomberra Creek the only other significant drainage line is a creek located at the eastern end of the common route. This drainage line also runs south to north and flows into the Jerrabomberra Creek to the north of the



study area. Neither of the creeks contained flowing water during either the October or December surveys. The study area is currently occupied by a number of rural residences at very low densities. The study area is almost entirely privately owned with the very eastern end made of Travelling Stock Reserves (TSR) and the north eastern section covered by a large quarry owned by CEMEX, Australia Pty Limited.

### **1.3.3 Locality**

The locality includes the area inside a 10-kilometre buffer of the subject site. It forms part of the South Eastern Highlands bioregion. The South Eastern Highlands Bioregion lies just inland from the coastal bioregions of the South East Corner and the Sydney Basin, bounded by the Australian Alps and South Western Slopes bioregions to the south and west (IBRA website). The bioregion includes most of the ACT and extends south into Victoria. The Locality includes Queanbeyan and Jerrabomberra in the north; sections of the Australian Capital Territory (ACT) including Tuggeranong and Woden are located in the west. Googong Dam and its foreshores and the Molonglo Range are located in the east of the locality and the large areas in the south are rural land holdings.



- LEGEND**
- Alignment Option
  - Common Route
  - Option 1B (Preferred Route)
  - Option 5
  - Study Area



CLIENTS | PEOPLE | PERFORMANCE



## 2. Methods

### 2.1 Desktop Assessment Using Previous Studies

A thorough desktop assessment has been undertaken, including the ecological survey results for parts of the subject site and locality of the proposed Edwin Land Parkway (ELP) extension. Additional references were sourced for areas outside of the locality of the ELP extension. The documents listed below were used as references and reading materials throughout the preparation of this report and field studies:

- ▶ BES (2007): Flora and Fauna Assessment for Proposed Extension of Edwin Land Parkway Stage 1: Jerrabomberra to Karabar.
- ▶ BES (2008) Biodiversity Study Findings Report – Queanbeyan Local Government Area.
- ▶ Biosis (2003) Natural heritage assessment of Tralee, Queanbeyan, NSW. Report prepared for Queanbeyan City Council, June 2003.
- ▶ Biosis (2003): Final Draft: Flora and Fauna Habitat Assessment at 300 Lanyon Drive (Poplars).
- ▶ Biosis (2003): Natural Heritage Assessment of 'Tralee' Queanbeyan, NSW.
- ▶ Biosis (2006) Ecological assessment: Tralee road links. Report prepared for Queanbeyan City Council, May 2006.
- ▶ Crawford, I. (2004) South Tralee: additional surveys of vegetation and birds, December 2003. Report prepared for URS, January 2004.
- ▶ GHD (2009) Species Impact Statement for the proposed Edwin Land Parkway Extension. Final report prepared for Queanbeyan City Council, May 2009.
- ▶ Kevin Mills & Associates (2005) Flora and Fauna Assessment – Stage 5, Royalla Estate, City of Queanbeyan.
- ▶ Kevin Mills and Associates (2004) Survey of the grasslands on South Tralee, City of Queanbeyan. Report prepared for the Village Building Company, January 2004.
- ▶ Kevin Mills and Associates (2007) Investigation of the endangered plant *Swainsona recta* in the vicinity of Tralee, City of Queanbeyan. Report prepared for Queanbeyan City Council, May 2007.
- ▶ Kevin Mills and Associates (2009) Flora and fauna surveys south Jerrabomberra properties, City of Queanbeyan: Summary of results. Report prepared for Village Building Company and Larcombe Family, May 2009.
- ▶ Rowell, A. (2003) Beatty Hill, Yarrowlumla Shire, NSW. Targeted flora and fauna survey of the site proposed for subdivision. Prepared for Northrop Engineers.
- ▶ Rowell, A. (2003) Survey for Golden Sun Moth, *Synemon plana* at Tralee, NSW, Queanbeyan. Report prepared for URS, December 2003.
- ▶ SMEC (2007): Flora and Fauna Survey for 2 Cook Avenue, Dodsworth (Brickworks).
- ▶ Thompson and Mullins (2004) Environmental Assessment Googong Urban Investigation Area, Report No. 66. Johnstone Centre, Research in Natural Resources & Society.
- ▶ URS (2004) Additional flora and fauna surveys for Tralee release areas. Final report prepared for Queanbeyan City Council, March 2004.



- ▶ URS (2005a) Ecological constraints for the Tralee Release Area, February 2005. Report prepared for Queanbeyan City Council.
- ▶ URS (2005b) Tralee Local Environment Study. Final report prepared for Queanbeyan City Council., March 2005.

Review of relevant databases and other information sources such as:

- ▶ NSW DECC: Atlas of NSW Wildlife, Bionet and FaunaNet.
- ▶ Department of Environment, Water, Heritage and the Arts (DEWHA): Protected Matters Search Tool covering Threatened Species and Communities, and Migratory and Other Species under the EPBC Act.
- ▶ Other databases (operated by Australian Museum and Royal Botanic Gardens etc) and Natural Heritage Trust: Planning Framework for Natural Ecosystems of the ACT and NSW Southern Tablelands (including mapping of key ecological communities such as Box-Gum Woodland).

It is noted there are a number of recent or ongoing surveys that have been conducted in the locality that may provide further detail on the presence of threatened species within the locality. These may include recent surveys conducted at “Environa” and “Robin” and the Old Cooma Road Quarry Plan of Management. GHD did not have access to these documents prior to field surveys. These documents and any other report of surveys conducted recently in the locality should be reviewed prior to any additional survey.

## 2.2 Field Surveys for Flora and Ecological Communities

The surveys were conducted from 28 - 31 October 2008. Details of flora survey techniques and effort undertaken during surveys are summarised in Table 1. Flora surveys were conducted across the subject site, including general flora surveys and targeted surveys for Endangered Ecological Communities in the wider study area. Although threatened flora species were found during survey period, targeted surveys for threatened species were not conducted. Targeted surveys for threatened plants would likely be conducted as part of more detailed studies completed for a Species Impact Statement, if the proposal proceeds.

**Table 1 Summary of Survey Effort for Flora and Ecological Communities Within the Study Area**

Group	Method and Effort
General Flora	<p><i>Quadrats</i> – Nine quadrats throughout the study area within the Common Route, Option 1B and on Option 5.</p> <p><i>Transects</i> – two transects within the study area along sections of the proposed route.</p> <p><i>Random traverse</i> – recording incidental species in each vegetation community</p>
Threatened Species	<p><i>Targeted searches</i> – Random meander transects in areas of potential habitat.</p> <p><i>Habitat assessment</i> – for threatened species known or likely to occur within the locality.</p>
Ecological communities	<p><i>Quadrats</i> – Nine quadrats throughout the study area</p> <p><i>Random traverse</i> – recording incidental species in each vegetation community</p>



Flora surveys were completed using quadrats and random meander transects along the proposed route options for Dunn’s Creek Road (Figure 2). Both the subject site and study area were surveyed, with the majority of survey effort completed in the subject site where the direct impacts of the proposed activity are likely to occur.

The BioMetric (Gibbons *et al.* 2008) survey technique was used to survey quadrats of 20m × 50m. For each quadrat, records were taken of vegetation characteristics, structure, litter, proportions of native and introduced plants and other habitat attributes relating to the ecological quality of the site. Notes were also taken of the dominant species, soil type and condition, the level of weed invasion and any other signs of disturbance.

Within each 20m × 50m quadrat a nested 20m × 20m quadrat was surveyed for flora composition. All species present within each quadrat were recorded and a cover abundance ranking assigned to each species. Abundance data was then used in assisting in the assessment of Commonwealth threatened ecological communities. In addition to the species recorded within the 20m × 20m quadrat, any additional species occurring within the 20m × 50m quadrat were recorded for assessment against the EPBC criteria for Box-Gum Woodland, which is based on an area of 0.1 hectares.

In determining if a patch of woodland classified as EPBC Box-Gum Woodland, the criteria in Table 2 were used in the assessment of if a site was EPBC Box Gum Woodland or derived grassland.

**Table 2 EPBC Box Gum Woodland listing criteria**

Criteria	Description	Does the site meet the criteria?	The community?
1	Does the site contain or previously have contained White Box, Yellow Box or Blakely’s Red Gum?		
2	Does the site have a predominately native understorey?		
3	Is the patch 0.1 ha or greater in size?		
4	Is there <30% shrub cover across the entire remnant?		
5a	Are there 12 or more native understorey species present (excluding grasses)?		
5b	Does the site contain at least one important species?		
<b>Outcome</b>			Yes / No
6	Where sites do not meet the criteria 4a and 4b, is the patch 2 ha or greater in size?		
7	Does the 2ha patch have 40 or more trees with a dbh >40cm? (i.e. 20 per hectare)		
<b>Outcome</b>			Yes / No



Criteria	Description	Does the site meet the criteria?	The community?
8	In the 2ha area, are there mature trees and natural generation (>5cm dbh) of dominant overstorey Eucalypts (WB, YB, BRG)?		
<b>Outcome</b>			Yes / No

All vegetation types within the alignment routes (within a 50m buffer each side of the proposed alignments) and the surrounding study area were mapped according to the vegetation categories within the BioMetric Operation Manual (Gibbons et al. 2008). Low or moderate/good condition classes were assigned according to the definition of low condition vegetation:

- ▶ Native woody vegetation with an overstorey percent foliage cover <25 percent of the lower value of the over storey percent foliage cover benchmark for that vegetation type.
- ▶ Native woody vegetation where <50 percent of vegetation in the ground layer is indigenous species.
- ▶ Native grassland where <50 percent of vegetation in the ground layer is indigenous species.
- ▶ Native woody vegetation or grassland is >90 percent ploughed or fallowed.

Vegetation communities with the potential to be Endangered Ecological Communities were assessed through survey of quadrats (as described above) placed at random within each vegetation community. The area of the vegetation community present within the subject site determined the number of quadrats surveyed in each.

Targeted flora surveys were undertaken in areas for which threatened flora habitat was present. Random meander transects were completed within these areas and any threatened flora species recorded. The position of any threatened species was marked with a Global Positioning System (GPS) and mapped using ArcView Geographic Information System (GIS).

Incidental observations of all other flora were also recorded whilst on site; these are included in Appendix B.

## 2.3 Field Surveys for Fauna

Four GHD ecologists conducted a range of targeted surveys and habitat searches from 28 - 31 October 2008, and from 1 - 2 December 2008.

### 2.3.1 Reptiles

Searches for potential reptile habitat were conducted along the routes of Option 1B, Option 5 and the Common Route. Areas suitable for native reptiles, particularly threatened species were recorded during site surveys. Areas that form potential reptile habitat including native grasslands, rocky habitats and woodland areas containing termite mounds were targeted during surveys.

Targeted surveys were conducted for the Pink-tailed Worm-lizard (*Aprasia parapulchella*) and Striped Legless lizard (*Delma impar*) in suitable habitat. Surveys for Pink-tailed Worm-lizard were conducted in rocky outcrops on lightly treed or treeless steep slopes. Shallow embedded rocks were rolled between 1000 hours and 1600 hours. Some rock rolling surveys were conducted later in the day. A rocky outcrop was searched until all suitable rocks along a random meander transect were rolled, or until evidence of

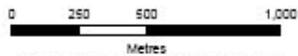
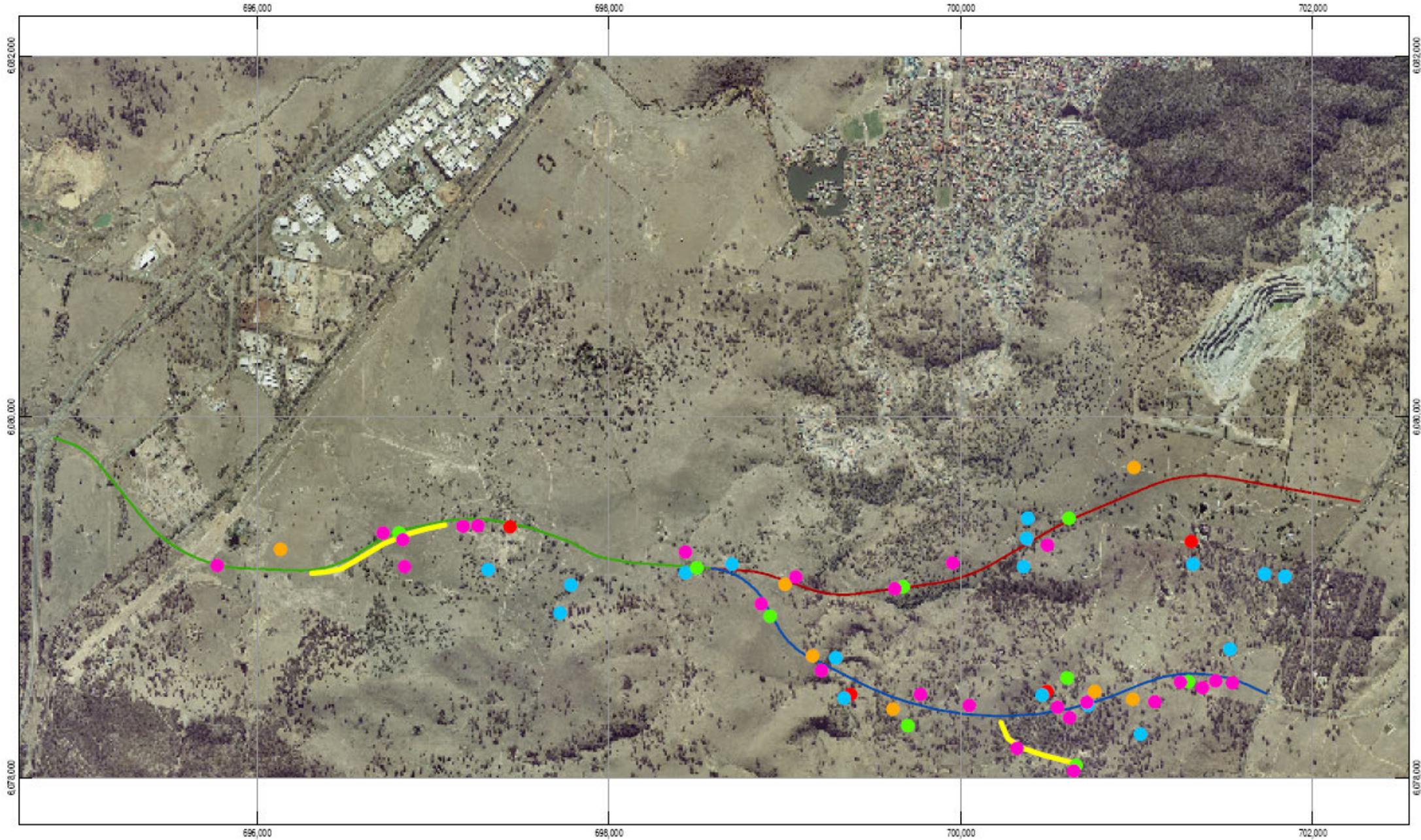


Pink-tailed Worm-lizard habitation was observed. Evidence of habitation was taken to be the observation of a live specimen, or the shed skin of a Pink-tailed Worm-lizard. If evidence of habitation was observed the rock roll was discontinued in that immediate area to prevent unnecessary disturbance to known habitat.

Habitat searches for the Rosenberg's Goanna (*Varanus rosenbergi*) were conducted in conjunction with other surveys. Potential habitat was considered to be open woodlands with suitable foraging and breeding habitat. An active termite mound search was not conducted however any termite mounds that were observed during other searches were recorded using a hand-held GPS.

Habitat searches for Grassland Earless Dragon (*Tympanocryptis pinguicolla*) were conducted by identifying suitable vegetation communities and landscape characteristics within the study area. Likewise suitable potential habitat was identified for the Little Whip Snake (*Suta flagellum*) in the form of native grasslands and woodlands with predominantly native understorey. Habitat searches for Grassland Earless Dragon were conducted in Natural Temperate Grassland areas. The species prefers areas with a more open structure, characterised by small patches of bare ground between the grasses and herbs (DECC 2008). Searches for the Little Whip Snake (*Suta flagellum*) were conducted in suitable habitat consisting of Natural Temperate Grassland, secondary grassland and grassy woodland with a predominantly native understorey, particularly where there were well-drained hillsides with scattered loose rocks.

All species recorded are in Appendix C.



**LEGEND Alignment Option**

- Common Route
- Option 1B (Preferred Route)
- Option 5

**Survey location**

- Anabat
- Bird
- Golden Sun Moth
- Flora quadrat
- Rockroll
- Flora transect



CLIENTS | PEOPLE | PERFORMANCE

N:\AU\Wagga Wagga\Projects\23112973\CADD\GIS\ArcView\Workspace\Report\Survey\_locations.mxd

© 2008. While GHD has taken care to ensure the accuracy of this product, GHD, Queanbeyan City Council and Department of Lands make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD, Queanbeyan City Council and Department of Lands cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

GHD: Ecology survey locations 2008, Queanbeyan City Council: Alignment Options, Department of Lands: Aerial photography. Created by: R. Robinson



### 2.3.2 Amphibians

Amphibian searches were conducted in any suitable habitat along the proposed routes, including creeks, drainage lines and farm dams. Targeted searches of the Green and Golden Bell Frog (*Litoria aurea*), Yellow-spotted Bell Frog (*Litoria castanea*) and Southern Bell Frog (*Litoria raniformis*) were not undertaken due to a lack of suitable habitat for these species. In addition, rainfall leading up to the survey period was low resulting in few areas of resident or transitory potential habitat in the form of ephemeral pools. Any incidental records of other frog species heard or sighted during the surveys were noted.

### 2.3.3 Birds

Diurnal bird surveys were conducted using sampling plots stratified to vegetation communities and minimum 20 minute, one-hectare searches. Searches were conducted using stationary and moving techniques, and were conducted in the early morning and late afternoon. A total of 16 bird surveys were conducted across the study area with particular attention given to the subject site where likely impacts would be greatest. All bird species heard or sighted at any time during the survey period were recorded as incidental records. Habitat surveys were also conducted for threatened species, with notes taken on vegetation, landscape and habitat characteristics.

### 2.3.4 Mammals

Sound activated recording devices (Anabat II Bat Detectors) were placed in suitable flyways or near water within a variety of vegetation communities to detect the presence of bats. The detectors were set before dusk and retrieved each morning. Two Anabat detectors were used on two consecutive survey nights (29 and 30 October), giving a total of four survey locations along the proposed route.

Bat calls collected during the field survey were identified using Analook software and zerocrossing analysis by visually comparing call traits with reference calls. No reference calls were collected during the survey. The reference *Bat calls of NSW: Region based guide to the echolocation calls of microchiropteran bats* (Pennay *et al.* 2004) was used as a guide for call analysis. Due to the high level of variability and overlap in call characteristics, a conservative approach was taken when analysing calls. This meant that any calls likely to have been made by a non-threatened species, but which could have been made by a threatened species, were recorded as a potential call from a threatened species.

A call was defined as a sequence of three or more consecutive pulses of similar frequency. Pulses separated from another sequence by a period of five seconds were considered to be separate calls. Scattered sequences, where intermittent pulses were not separated by more than five seconds, were recognised as a single pass. Where constant activity was recorded, a single pass was defined as 15 seconds (i.e. one full display screen). Although this method underestimates the number of bat passes when there is continuous activity, the standard unit of time remains consistent (Law *et al.*, 1998; Law *et al.*, 1999).

Due to variability in the quality of calls and the difficulty in distinguishing some species the identification of each call was assigned a confidence rating (see Mills *et al.* 1996 & Duffy *et al.* 2000; Table 3).



**Table 3 Confidence Ratings Applied to Calls**

Identification	Description
D - Definite	Species identification not in doubt.
PR - Probable	Call most likely to represent a particular species, but there exists a low probability of confusion with species of similar call types.
PO - Possible	Call characteristics are comparable with the species, but there exists a reasonable probability of confusion with one or more bat similar species or quality or length of call prohibits a confident identification.
Species Group	Call made by one of two or more species. Call characteristics overlap making it to difficult to distinguish between species. <i>C. gouldii/M. planiceps (lpf)</i> <i>C. gouldii/S. balstoni.</i> <i>Nyctophilus sp.</i> The calls of <i>Nyctophilus geoffroyi</i> and <i>N. gouldi</i> cannot be distinguished during the analysis process and are therefore lumped together.

The Queanbeyan City Council is not listed under Schedule 1 of *State Environmental Planning Policy 44 – Koala Habitat Protection*. However, results from 20m x 20m flora quadrats, were used to assess whether any of the vegetation communities on-site support potential Koala habitat. Potential Koala habitat is defined as that where Koala feed tree species in the upper or lower tree strata constitute at least 15 percent of the total number of trees within a vegetation community. Active Koala searches were not undertaken; however assessments were made of potential habitat during the surveys conducted across the study area.

Other mammals were recorded from incidental observations during surveys for other biota. Targeted surveys were not conducted for any other mammal species because the study area was not considered to contain habitat for any other threatened mammals.

### 2.3.5 Invertebrates

The study area contains known habitat for the Golden Sun Moth (*Synemon plana*). This species is listed as endangered under the NSW TSC Act and critically endangered under the Commonwealth EPBC Act. There is known habitat for this species in the east of the alignment route, however it may also occur in other areas not previously surveyed in the alignment routes.

The Golden Sun Moth occurs in Natural Temperate Grasslands and grassy Box-Gum Woodlands in which the groundlayer is dominated by wallaby grasses (*Austrodanthonia* spp.) (DECC 2008). This species is known to be active during the warmest hours (1000 hours – 1400 hours) of sunny, still days from mid-November through December in the ACT (DECC 2008). Areas of *Austrodanthonia* spp. (particularly *Austrodanthonia carphoides*) were recorded during the October survey period for later targeted surveys. There are known records for this species in the east of the study area near Googong, and in the west of the study area. GHD ecologists attempted to survey for this species during ideal conditions to optimise survey effectiveness.

Golden Sun Moth surveys were conducted on 1 and 2 December 2008 by two GHD ecologists. Sites identified during the October survey period were targeted during the December surveys. Surveys were



undertaken between 1000 hours and 1400 hours in native grasslands where *Austrodanthonia* sp., particularly *Austrodanthonia carphoides*, was present. Surveys were conducted by random meander transect within grasslands. Any suspected Golden Sun Moth was caught by sweep net and a positive identification was made.

Biosis (2003) and Thompson and Mullins (2004) have conducted targeted threatened species surveys including the Golden Sun Moth within parts of the current study area. The survey effort and conclusions of these previous surveys were considered in the current survey design.

**Table 4 Summary of Survey Effort for Fauna and Invertebrates Within the Study Area**

Group	Method and Effort
Reptiles	<p><i>Active searches</i> – Rock and log rolling across the site to search for threatened species and non-threatened species. Approximately 900 rocks were rolled at more than 30 locations along the route option alignments.</p> <p><i>Habitat identification</i> – general surveys to identify area of potential habitat for threatened species.</p> <p><i>Opportunistic</i> – any species recorded at any time during the survey period.</p>
Amphibians	<p><i>Habitat search</i> – to identify potential threatened species habitat.</p> <p><i>Opportunistic</i> – identifying all amphibians observed or heard at any time during the survey period.</p>
Diurnal birds	<p><i>Target Survey</i> – 16 bird surveys along the Common Route, Option 1B and Option 5 to identify all species present.</p> <p><i>Habitat identification</i> – general survey to identify potential threatened species habitat.</p> <p><i>Opportunistic</i> – any species recorded at any time during the survey period.</p>
Mammals	<p><i>Habitat identification</i> – general survey to identify potential habitat, particularly threatened species habitat.</p> <p><i>Opportunistic</i> – any species recorded at any time during the survey period.</p> <p><i>Anabat Detector</i> – two consecutive nights with two Anabat units to identify microchiropteran bats</p>
Invertebrates	<p><i>Habitat identification</i> – vegetation surveys across the site to identify habitat for threatened species</p> <p><i>Active search</i> – sweep netting at seven locations across the site to identify active threatened invertebrates.</p>



## 3. Results

### 3.1 Weather Conditions

The following results are from two survey periods, one in October and one in December. Table 5 is a summary of the weather conditions that occurred within the locality during the two survey periods.

**Table 5 Weather Conditions at the Canberra Airport During Dunn's Creek Rd Surveys**

Date	Minimum Temperature (C)	Maximum Temperature (C)	Rainfall (mm)
<b>Survey Period One</b>			
29/10/2008	12.5	19.9	0
30/10/2008	12.5	26.9	0
31/10/2008	12.3	30.2	0
<b>Survey Period Two</b>			
01/12/2008	13.6	25.2	0.2
02/12/2008	5.6	24.5	0.0

Targeted surveys for the Golden Sun Moth were conducted on 1 - 2 December 2008. Weather conditions during the survey period included generally moderate to high winds with periods of no wind or slight wind. Temperatures reached maximums of 25.2°C on 1 December and 24.5°C on 2 December. Although the Golden Sun Moth surveys were conducted at an ideal time of year, the windy conditions during the surveys made conditions less than optimal.

### 3.2 Flora and Ecological Communities

#### 3.2.1 Ecological Communities

One ecological community listed as endangered and one listed as critically endangered under the Commonwealth EPBC Act were observed during the survey period. In addition, one ecological community listed as endangered under the NSW TSC Act was recorded (Figure 3). Ecological communities recorded were:

- ▶ White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland – critically endangered EPBC Act;
- ▶ White Box Yellow Box Blakely's Red Gum Grassy Woodland – endangered TSC Act; and
- ▶ Natural Temperate Grassland – endangered EPBC Act.

Blakely's Red Gum (*Eucalyptus blakelyi*) was also found in the study area, but was less common. The occurrence of these tree species as significant proportions of the canopy vegetation contributed to the classification of much of the proposed route option alignments as Box-Gum Woodland (TSC and EPBC). In addition, the groundcover vegetation along the alignments was good condition (i.e. not low condition), with a predominance of native species (greater than 50 percent abundance cover). Exotic species were



found to occur throughout the study area; however these species only became dominant in a few locations.

In the eastern sections of the study area the groundcover was of sufficient quality for areas of woodland to be classified as Box-Gum Woodland as defined under the EPBC Act. These areas contained at least one important species listed in the community identification guidelines, as well as 12 native understorey species within an area of 0.1 hectares (50m × 20m). One area near the junction of the Common Route and the two alignments was also mapped as EPBC Box Gum Woodland based on the large number of mature Yellow Box trees occurring.