DRAFT

Appendix D

Heritage Report

Archaeological and Heritage Assessment

Desktop Study

Proposed New Road – Dunns Road, Jerrabomberra, NSW

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Report to: GHD Canberra Pty Ltd
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SUMMARY

Introduction

The Queanbeyan City Council in conjunction with the NSW RTA is investigating possible routes for a new road between the Monaro Highway in the ACT and Old Cooma Road in NSW. At this stage of the project the cultural heritage and archaeological assessment is a desktop study. As a route has not been finalized the study area is essentially a broad corridor between the two roads. The only route stipulation within the corridor was that the junction with the Monaro Highway was fixed.

The area under investigation is located at the southern end of the Jerrabomberra urban area at what is essentially the southern margins of Queanbeyan NSW. Within the ACT the area to the north of the route is occupied by the Hume Industrial Area. The final route options will need to cross two significant features in the landscape: the Queanbeyan-Cooma Railway Line, and Jerrabomberra Creek. The creek is the major stream in the study area.

Based on aerial photographs and various editions of maps the study area has been extensively exploited since European settlement. The uses have generally been confined to rural activities (ie farming/agriculture, and stock grazing).

This report documents the results of the above study, and includes:

- Outlines and discusses the significance of previous research carried out in the region and in the vicinity of Hume which is located within the southern Monaro Region.
- Presents a predictive model for various Aboriginal Site Types based on previous research in the region.
- Discusses the environmental background, previous research, survey methodology, surveys, and survey results for the study.
- Outlines Management issues for Aboriginal and European sites and culturally sensitive landscapes within the road corridor.

Archaeology of the Study Area

There have been at least three cultural or archaeological assessments carried out within the Dunns Creek Road corridor. These studies have resulted in a large number of Aboriginal (n=9) or European (n=7) cultural heritage sites being recorded. In addition a number of areas of Potential Archaeological Deposit (n=10) have been identified. The majority are at the western end of the study area near Old Cooma Road.

Generally the majority of these sites have a moderate to high cultural heritage significance rating on a local level.

Management Recommendations

Based on the known cultural heritage inventory of the study area there is essentially one management option. This is to avoid the main complex of Aboriginal and European archaeological sites and adopt a route confined to the southern part of the road corridor. It will however be necessary at a later stage to conduct further assessments of any route proposed. It is highly recommended that any route as much as possible, and considering other factors, should avoid the known sites.

Recommendations

Based on the results of the investigations carried out as part of this study and on the legislative obligations outlined in the relevant legislation it is recommended that:

- The route selected avoid as much as possible any previously recorded Aboriginal or European heritage sites, especially those with a high rating or which are complex sites.
- On cultural heritage grounds (both Aboriginal and European) the best route options are located towards the southern boundary of the Dunns Creek Road Corridor. The route can leave the roundabout on the Monaro Highway and terminate at, or to the south of, the roundabout at the junction of Old Cooma Road and Googong Road.
- Once the individual route options have been identified, as part of the final selection process, those routes should be subjected to archaeological investigation/survey. This includes within the areas that have already been surveyed.
- If the route will impact on any of the previously identified cultural heritage sites, including PADs further research in those areas will need to be conducted. This may include sub-surface investigations.
- Such surveys and investigations where they involve Aboriginal sites should be carried out in conjunction with representatives of the local Aboriginal community.
- At all stages during the process of final route selection the local Aboriginal community must be consulted and involved in the process.

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1. INTRODUCTION

The Project

The Queanbeyan City Council in conjunction with the NSW RTA is investigating possible routes for a new road between the Monaro Highway in the ACT and Old Cooma Road in NSW. At this stage of the project the cultural heritage and archaeological assessment is a desktop study. As a route has not been finalized the study area is essentially a broad corridor between the two roads (see Fig 1 and 2). The only route stipulation within the corridor was that the junction with the Monaro Highway was fixed.

The area under investigation is located at the southern end of the Jerrabomberra urban area at what is essentially the southern margins of Queanbeyan NSW. Within the ACT the area to the north of the route is occupied by the Hume Industrial Area (HIA). The final route options will need to cross two significant features in the landscape: the Queanbeyan-Cooma Railway Line, and Jerrabomberra Creek. The creek is the major stream in the study area.

Based on aerial photographs and various editions of maps the study area has been extensively exploited since European settlement. The uses have generally been confined to rural activities (ie farming/agriculture, and stock grazing).

As part of the planning for the project, a Desktop Cultural Heritage Study was commissioned by GHD on behalf of the QCC and NSW RTA to ascertain if there are any Aboriginal or European cultural heritage issues that may impinge on route selection. This report documents the results of the study, the aims of which were to:

- Carry out a desktop study aimed at identifying Aboriginal or European archaeological sites and associated features within or near the road corridor.
- Develop predictive models for Aboriginal sites and sensitive landscapes within the corridor (based on the results of previous research in the region);
- Assess the significance of any sites and features identified during the study; and
- Identify route options based on the location of known Aboriginal and European cultural heritage sites. And
- Identify management options for sites and sensitive areas based on present and predicted impacts.

Historical Setting

The historical back ground for the study area will not be explored in detail during the present study. A fairly comprehensive coverage can be found in two reports prepared in 2003 by Navin Officer Cultural Heritage Management Pty Ltd (Navin Officer 2003a; 2003b). European use of the area has been ongoing since the 1820s. Initially estates were established near Canberra, notably Robert Campbell's "Duntroon". The western section of the study area was part of a land grant made to John Palmer. During the early period of settlement grazing was the dominant industry. The adjacent eastern section appears to have been in the hands of Francis Mowatt.

From the late 1860s the larger holdings were generally broken up into smaller holdings as a result of the Robertson Land Acts of 1861. Generally the land taken up by the new settlers were the more marginal lands. By the end of the 19th Century the area had become one of a mix of small holdings held as either Conditional Purchases or Conditional Leases, or as rumps of the original large land grants from earlier in the Century.

The Report

This report documents the results of the above study, and includes:

- Outlines and discusses the significance of previous research carried out in the region and in the vicinity of Hume which is located within the southern Monaro Region.
- Presents a predictive model for various Aboriginal Site Types based on previous research in the region.
- Discusses the environmental background, previous research, survey methodology, surveys, and survey results for the study.
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Figure 1: Map Showing study area and Aboriginal and European Cultural Heritage Sites.
(Base Maps Canberra and Tuggeranong 1:25K Topo)

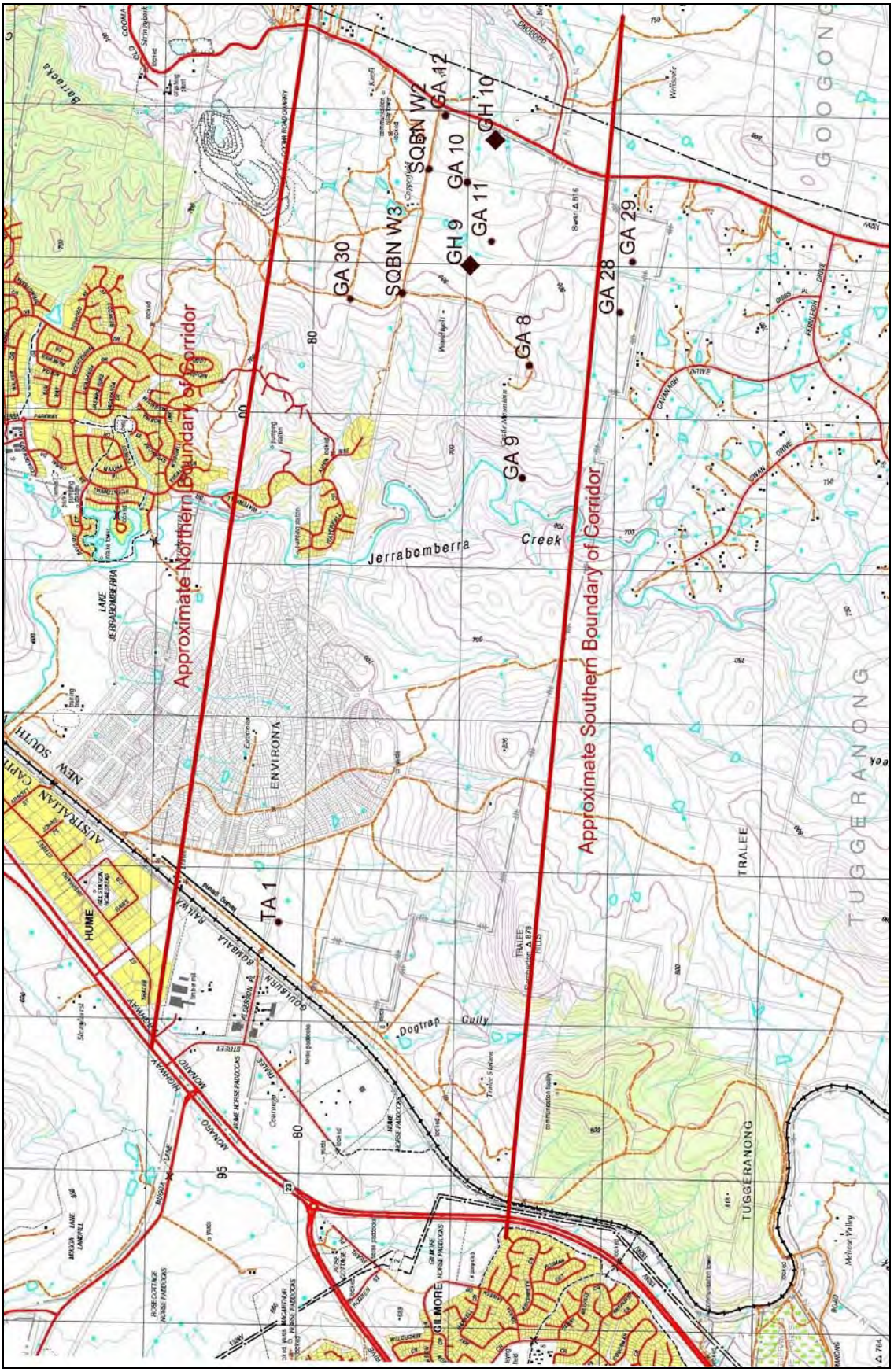


Figure 2: Aerial view of the study area showing road corridor (Source Google Earth).



2. ENVIRONMENTAL FACTORS

Introduction

The study area has been highly modified since European settlement began in the Canberra-Queanbeyan District in the 1830s. The area has been disturbed by various phases of land use including grazing and more recently urban development. Because of the disturbance caused to the soil deposits in the last 180 years it is assessed that much of the original soil layer has been removed or covered by introduced fill, with removal occurring as a result of either water or wind erosion.

Vegetation

The native woodland which once dominated the area has been generally cleared from within the Dunns Creek Road corridor. The area scattered woodland trees (eucalypts) scattered across the area. Where the native vegetation has been removed the land has been turned over to pasture. Its predominant use at present is for grazing and agistment of stock.

Disturbance

Based on the consultants knowledge of the area, and on the evidence contained in satellite and aerial images disturbance within the study area has been extensive. One of the major factors contributing to the disturbance is erosion. Evidence of the effects of erosion either prehistoric or historic was evident: such as the infilled terrace on the main drainage lines through the area. Areas that have been highly disturbed by heavy machinery operation are particularly susceptible to erosion. This is especially so near the Queanbeyan-Cooma Railway Line and on Tralee Station.

The area has been subjected to extensive grazing and other activities for up to at least 180 years. Disturbance within the study area has been caused by:

- Clearance of the native vegetation
- movement and grazing of stock;
- erosion, including sheet erosion and gullying;
- fence, road, utilities construction;
- Railway construction;
- Industrial area development;
- Urban development;
- Activities associated with the old Tralee Speedway; and
- Probable airfield construction.

Water Availability

The Jerrabomberra area is well drained with a large number of drainage lines eventually flowing into either Jerrabombera Creek or the Queanbeyan River which are the dominant streams in the district. The main ridge near the eastern end of the Dunns Creek Road corridor forms the divide between the two systems. Based on observation made along the Edwin Land Parkway easement water flow after heavy rain on both sides of the divide is substantial.

Since European settlement of not only the Canberra-Queanbeyan area, but the southern highlands as a whole, major changes in the form and characteristics of the rivers and streams in the region have occurred. Much of the change has been in the form of channel degradation (White 2000: 112). Explorers in the early 19th Century described the river channels in the Southern Highlands as being predominantly "chains of ponds" with intervening swamps

vegetated by native reeds. At that time the flood plains of these streams consisted of organic rich loam and clay loam overlying a variety of alluvial and colluvial deposits. According to White (2000:114), between 1850 and 1950 almost all the chains-of ponds reaches of the streams were transformed into continuous incised channels in which significant sediments were transported. Many of the rivers were transformed within a couple of decades of European settlement. The cause of increased runoff and modification of the river channels is attributed to the clearance of the native vegetation and the effects of over-grazing by introduced stock.

After rain the drainage lines that feed into Jerrabombera Creek and the Queanbeyan River and which pass through the study area will contain various quantities of water, both static and running. In prehistoric times it is not known how much of this water would have been available as standing water for Aboriginal people.

Conclusion

The area in and around the present study area may have been an ideal locality for Aboriginal people to exploit. Near permanent water may have been available. In addition it is considered that reliable food and other resources would have been available. Since European settlement severe disturbance of the area has occurred. It is assessed that this disturbance will have affected the survivability of Aboriginal cultural heritage material, especially insitu material, which may have been present in the area.

3. METHODOLOGY AND RESULTS OF HERITAGE SEARCHES

Study Methodology

A range of documentation was consulted during the study. The material was reviewed to ascertain the extent of known Aboriginal exploitation of the area and to ascertain the history and heritage significance of the study area and its surrounds. Resources consulted during the study included:

- Department of Environment and Heritage, including Register of the National Estate;
- National Library of Australia (NLA);
- ACT Heritage Unit;
- CHD - DECC;
- Various databases maintained by different organisations including the Land and Information Centre. Some of these sources were consulted via the Internet.

Also reviewed was a large corpus of information (reports and theses) that are within the consultant's collection, or were loaned by other archaeological consulting organisations, or were available from the ACT Heritage Unit and DECC.

Results of Searches

Register of National Estate

A number of items/places (n=40) in or near Hume, ACT and Queanbeyan, NSW are listed on the RNE. The majority of the items are within the Queanbeyan Area (n=39) which include both European Heritage Places and Natural Heritage places. No items of Aboriginal cultural heritage were identified. Of the 40 items, seven are shown as either being destroyed (n=2) or rejected for listing. The Heritage Places close to the Dunns Creek Road corridor are identified in Table 1.

Table 1: Places Listed on the RNE near the Dunn Creek Road Corridor

Site Name	Address	Status
Woden Homestead	Hume, ACT	Registered
Mt Jerrabombera Area (native woodland/grassland)	Jerrabombera, NSW	Registered
Poplars Rutidosis Site (native grassland/woodland)	Jerrabomberra, NSW	Registered
Tralee-Williamsdale Railway Swainsonia Sites (natural grassland communities)	Williamsdale, ACT/NSW	Registered

None of the items are within the present study area. None will be impacted by the proposed upgrade.

ACT Heritage Register

Under the terms of the ACT *Heritage Act 2004* the ACT Heritage Council is required to maintain a register of all Aboriginal and European heritage sites within the ACT. The Heritage Register is maintained by the ACT Heritage Unit, Territory and Municipal Services on behalf of the Council. The aim of the register is to "represent and protect the rich natural and cultural

heritage of the ACT, encompassing both Aboriginal and post European cultural values". Listing on the ACT Heritage Register means that the place or object is:

- of particular importance to the people of the ACT and enriches our understanding of history and identity;
- is legally protected under the Heritage Act 2004 including the application of Heritage Guidelines;
- requires advice by the ACT Heritage Council on development issues to improve conservation outcomes; and

A search of the register was carried out to ascertain if any places within or near Hume were identified on the ACT Heritage Register.

There are a number European Sites listed on the register close to Hume/Jerrabomberra. There are also a large number of minor European sites recorded in the area. The majority are in the corridor between the Monaro Highway and Jerrabomberra Creek north of Lanyon Drive. These minor items include: fence lines, farm machinery, building remains, vehicle remains, and quarries.

In addition there are a number of recorded Aboriginal sites within the ACT. These sites include scarred trees, open artefacts scatters (including Isolated Finds) and quarries

NSW Heritage Register/Inventory

Seven items/places in or near Hume, ACT and Queanbeyan, NSW are listed on the NSW State Heritage Register (SHR). The majority of the items are within the Queanbeyan Urban Area. Similarly a large number of items (n=30) were found on the NSW State Heritage Inventory (SHI). None are close to the present study area. None will be impacted by the proposed upgrade. Items are placed on the SHI if they are identified by Local or State Government agencies as having local or state heritage significance and which are under the control of those agencies. Such listings include Local Environment Plans and the RTA Heritage Register.

AHIMS Register Search

The Cultural Heritage Division, through its Aboriginal Heritage Information Management System (AHIMS), maintains a register of all recorded Aboriginal Sites within the state of New South Wales. A search of the register was requested to ascertain if any sites were known to be in the area of the road corridor, and to identify previously recorded sites in the surrounding area. The areas searched encompassed the 1:25k Topographical Map Sheets on which the study area is located:

- Tuggeranong 1:25k – Sheet 8727-III-S, 1st Edition.

The area requested to be searched generally encompassed an area approximately 10 km out from the study area boundaries. The search produced an incomplete listing of sites in the area. It was known that a number of recorded sites were located in areas in which none were identified. As a result a check was carried out with other consultants and a fuller picture of the extent of sites in the area obtained.

Details of various studies carried out in or near the Dunns Creek Road Corridor are explained in Section 4 or the report. In all these were close to 100 sites identified in the vicinity. Of these nine are within the corridor. The significance and management of these sites will be discussed in detail in later sections of the report.

4. PREVIOUS RESEARCH

Ethnohistory

Introduction

The most comprehensive ethnohistorical analysis and interpretation for the Southern Uplands have been conducted by Flood (1973, 1980). Other researchers including Bulbeck and Boot (1990) and Barber and Williams (1996) have used Flood's research for areas in or near the ACT.

"Tribal" Boundaries

Based on the evidence contained in the works of Tindale the area along the Murrumbidgee River within the ACT appears to have been occupied by up to three Aboriginal groups. The most northerly was the Ngun(n)awal who occupied the northern part of what is now the ACT. Based on Tindale's 1974 Map the southern boundary for the Ngun(n)awal is roughly along a line close to the Molonglo River.

It is highly probable that tribal boundaries, clan estates, and band ranges were fluid, varying over time. Consequently tribal boundaries as delineated today must be regarded as approximations only, and relative to the period of, or immediately before European contact (Syme 2005). As well the lines drawn on Tindale's Map are intended only as a guide to the boundaries he has identified.

South of the Ngun(n)awal were the Wolgal and Ngarigo People. The boundary between the Wolgal and Ngarigo people appears to have been close to, or may have been the Murrumbidgee River with the Wolgal being in the western side of the river. The Ngarigo appear to have occupied the southern Monaro reaching as far north as Queanbeyan. Again the boundaries on Tindale's Map are indicative of the areas occupied by a particular group.

Linguistically, the three groups spoke a language that Dixon (1980) classed as Ngarigo indicating that there was a common underlying link between the people of the southern tablelands and uplands. Bulbeck and Boot (1990) describe the language area as an Aboriginal socio-ecological area with common links including that of Bogong moth exploitation. Others (Knight pers comm) argue that the groups were sub-groups of the Wiradjuri.

Archaeology

Introduction

Since at least the 1970s extensive archaeological research has been carried out within the ACT and surrounding NSW. Much of this research has been initiated by various types of development: residential, rural residential, industrial, and infrastructure. As well a low level of academic research has also taken place. Following the ACT Bushfires of 2003 Environment ACT, the ACT Heritage Unit carried out extensive archaeological surveys of areas affected by the fires or which had been disturbed by the construction of fire containment lines. This later phase of research resulted in a huge number of Aboriginal sites being recorded within the ACT. The results surprised many including those taking part in the surveys. As one consultant archaeologist stated (Paton nd):

> "The results have been somewhat surprising for the archaeologist. … If one looks at the map … with sites plotted, you are left with the impression of Aboriginal occupation clustered in broad valleys, with more inaccessible, higher terrain only used occasionally. … (O)ccupation of a region is a matter of emphasis on different land systems and the uniqueness of adaptations."

Regional Level

Archaeological research has shown that Aboriginal people have occupied Australia for at least 40,000 years and possibly for as long as 60,000 years (Mulvaney and Kamminga 1999: 2). By 35,000 years ago all major environmental zones in Australia, including the periglacial areas of Tasmania, were occupied (Mulvaney and Kamminga 1999: 114). Occupation of south-eastern Australia by Aboriginal people during the Late Pleistocene has been confirmed by radio carbon dating carried out at a number of sites (eg Boot 1996; Bowdler 1970; Lampert 1971, Ossa et. al 1995). Based on dating evidence from at least three locations relatively close to or in the Canberra-Queanbeyan area it could safely be assumed that occupation of the area dates to at least the late Pleistocene. The three locations and their occupation dates are: Birrigai Rockshelter in the ACT dated to between 21,000 and 3,000 years BP (Flood et al); Wombeyan Caves dated to about 10,000 years BP (Navin Officer 2003b); and Bulee Brook and Bob's Cave in the South Coast Hinterland dated to between 10,000 and 12,000 years BP (Boot 1994).

During the early period of Aboriginal occupation of Australia, the climate was moderate. However, between 25,000 and 12,000 years BP (a period known as the Last Glacial Maximum (LGM)) dry and either intensely hot or intensely cold temperatures (depending on the geographical region) prevailed over most of the Australian continent (Mulvaney and Kamminga 1999:114). During the LGM the mean monthly temperatures on land were between 6 to 10^{o} Celsius lower than present. South eastern Australia experienced cold, windy, and dry conditions all of which acted to change the vegetation structure from forest to dry grassy plains and /or shrub lands (Mulvaney and Kamminga 1999: 115-116).

At the end of the glacial conditions, temperatures rose, not only in Australia but throughout much of the world. The warmer conditions resulted in the huge ice masses of the northern hemisphere melting and causing a worldwide rise in sea levels. The melting of the ice sheets took several thousand years to complete. There were fluctuations in the rate of melt dictated by short periods of reversion to cooler temperatures. During the Late Pleistocene, that is before approximately 10,000 years BP, the sea level was as much as 130m below its present level. This resulted in many of the embayments along the coast, including Sydney Harbour being inland riverine valleys.

By about 6000 years BP world sea levels had more of less stabilised to their current position. There were some minor fluctuations after that stabilisation, especially at around 4,000 years BP. With the changes in climate during the last 10,000 years, a period known as the Holocene, Aboriginal people had to deal with a reduced landmass (especially along the coastal fringe), changing vegetation patterns, and changing hydrological systems. Forests again inhabited the grass and shrub lands present at the time of the Late Glacial Maximum.

The majority of recorded sites located in south-eastern Australia date from the mid to late Holocene (Dibden 2004).

Research in the Jerrabomberra Area

In 1984 Lewis (1984) surveyed the proposed 'Jerrabomberra Park' housing estate. Lewis' study area is located near the present study area. The development area included a section of Jerrabomberra Creek and its tributaries. Two open campsites were recorded. Lewis (1985) also surveyed the proposed Eastern Parkway in the ACT. The survey located one artefact scatter 50m east of Jerrabomberra Creek. The scatter contained twenty three artefacts and was associated with the exploitation of fine-grained siliceous stones occurring naturally at the site.

Ballard (1986) located an isolated find during a survey near Mt. Jerrabomberra.

Access Archaeology (1992) surveyed approximately 260ha along the western side of Jerrabomberra Creek beside the proposed Eastern Parkway. Three isolated finds were recorded.

A survey of a proposed Aquatic Facility near Symonston included land on both sides of Jerrabomberra Creek (Klaver 1997). Three open artefact scatters, six isolated finds and a quarry site were recorded. All of the sites were located on slopes away from the creek.

A reconnaissance level vehicular survey of the South Queanbeyan Development Area east of Jerrabomberra located four low density artefact scatters and one isolated find (Saunders 2001b). Raw materials were metamorphosed tuff, quartz, silcrete, volcanic and chert. Three of the sites were located on ridge crests and two were on low gradient basal slopes near a drainage line. Areas of high archaeological potential were identified along the eastern bank of Jerrabomberra Creek. Saunders (2003b) also surveyed a 6.5ha rural block immediately east of suburban Jerrabomberra. No sites were located.

A number of surveys have been conducted in the Hume Industrial area in the ACT. In 1994 Walshe surveyed the Hume Industrial Estate located on the Jerrabomberra Creek floodplain. No Aboriginal sites were located. Kuskie (1995) surveyed 10ha of gentle slopes on Block 6, Section 22. Again no sites were found. Avery (1997) located a possible Aboriginal scarred tree during a survey in Hume.

In 2000, Barber completed a comprehensive archaeological assessment of an 800ha area covering Hume and adjacent areas in the Tuggeranong and Jerrabomberra districts of the ACT. Nineteen Aboriginal sites were recorded. Sites comprised two scarred trees, eight small low density open artefact scatters and ten isolated finds. The study area and all sites are on the opposite side of the Monaro Highway from Hume. Based on topography, Barber (2000) also identified 17 archaeologically sensitive areas, consisting of gently sloping spurs or low rises near drainage lines. He concluded that small artefact scatters and isolated finds are the Aboriginal site types most likely to occur in the Hume area.

Navin Officer (2001) investigated the Mugga Resource Recovery Centre on Block 10 Section 23, Hume. Three previously recorded artefact scatters were re-assessed. The sites contained from three to seven artefacts and were associated with areas of low to moderate archaeological potential (Navin Officer 2001:19-21).

Saunders (2001c) surveyed the area of archaeological sensitivity identified by Barber (2000) on Block 7 Section 21, Hume, as part of a feasibility study for a gas-fired power station. The area was assessed as having low archaeological potential.

Navin Officer (2003) surveyed two proposed residential development areas totalling 229ha at 'Tralee' in NSW immediately south Hume. Part of the southern section of Navin Officer's study area lies within the Dunns Creek Road corridor. A low density scatter of two stone flakes was located in a low gradient simple slope/valley floor context within the proposed southern development area. A program of archaeological test pitting was recommended if the area is to be disturbed by development. The small site is within the corridor. It is assessed that the findings of Navin Officer will have a bearing on the location of the route selected and on further research in the area.

North of Lanyon Drive Navin Officer (2004a, 2004b, and 2005) carried out a number of archaeological surveys and sub-surface testing. The projects were associated with the proposed ACT Prison ('Alexander Maconochie Centre') and the ACT ESB Headquarters and Joint Emergency Services Training Academy. During the surveys and sub-surface testing – no Aboriginal cultural heritage material was recorded or recovered. Navin Officer carried out a small area survey just off Mugga Lane north of the Land Fill site. The study area was within the old Mugga Lane Zoo. 10 artefacts were recorded eroding from a well used vehicle track.

More recently in 2007 Dearling (2007a, 2007b) carried out an archaeological assessment for the proposed Lanyon Drive Upgrade and the proposed Edwin Land Parkway. The first study area

was located on the western side of the existing Lanyon Road and extended from the Monaro Highway in the ACT to Tompsitt Drive in NSW. During the study no Aboriginal cultural heritage material was found. The area was considered too highly disturbed to be able to identify is such material had been present. However three items of European Heritage were found: all associated with a previous alignment of Lanyon Road (Drive). Along the Edwin Land Parkway road reserve five Aboriginal sites were identified. All consisted of a low number of artefacts (n=1 to 8 artefacts) and all had a low density of artefacts.

The Edwin Land Parkway lies about 3 to 4 km north of the present study area and the route more or less parallels the proposed Dunns Creek Road. Both routes cross the same ridge line. In addition the later road crosses Jerrabomberra Creek.

Of immediate importance to the present study was one carried out by Navin Officer in 2003 in the Googong area. That study area straddled Old Cooma Road with the portion on the western side of Old Cooma Road lying within the Dunns Creek Road corridor. The project was carried out on behalf of the Queanbeyan City Council and Yarrowlumla Shire Council who were investigating a proposal to rezone rural land at Googong for a new residential development. The total area under investigation comprised approximately 1000 ha. Prior to the study eighteen previously recorded Aboriginal sites were known to be in the area (Navin Officer 2003). During the field surveys associated with the project 34 Aboriginal sites (identified as GA1 – GA34) were identified in the Googong LES area. In addition 24 areas of potential archaeological deposit (PAD) were identified. The sites located within the Dunns Creek Road corridor are shown on Fig 1.

5. ABORIGINAL SITE LOCATION MODELS

Proposed Exploitation/Site Location Model

Based on previous research in the Jerrabomberra District it is possible to propose a site location model for the region. The generally accepted model of Aboriginal exploitation of the region includes:

- The most common site type expected in the area will be those associated with stone artefacts, that is open artefact scatters and isolated finds. The majority of such sites will tend to be small both spatially, in the number of artefacts, and have a low artefact density.
- Along ridges/spurs sites will be located on relatively flat areas on crests of knolls, in saddles, or on shoulders or benches in mid to upper slope contexts. Such sites would tend to be small in spatial size and in the number of artefacts present.
- Close to major streams more complex sites could be expected. These sites would tend to be larger spatially, in the number of artefacts, and also have a higher density of artefacts. The focus of these sites would be on the relatively level areas close to the streams such as on foot/basal slopes and terraces.
- It is of note that within the Jerrabomberra area there is generally a lack of sites identified close to Jerrabomberra Creek. This phenomena has been commented on during discussions between archaeologist, and between archaeologists and representatives of the Aboriginal community.
- Site size and frequency decreases further away from water.

Site Types

Based on previous research in the surrounding region it can be expected that a number of site types may be found within the study area. The presence of a certain type of site will be dependent on a suitable environment being present. The types of sites that can be expected are outlined below.

Artefact Scatters. It is anticipated that Open Artefact Scatters will be the most common site type within the study area. These sites have been variously described as camping sites, stopping places, and tool maintenance and manufacturing sites. Irrespective of how they were formed they represent evidence of Aboriginal people discarding artefacts made predominantly from stone. It is generally accepted that larger and more complex sites are locations where major stone working took place, and may also be important stopping or camping places. Artefact Scatters may contain not only stone artefacts, but if conditions are suitable, bone material as well. Artefact Scatters may also be associated with other site types such as middens (on riverine and swamp margins) and rockshelters, and can vary in size and in the number and density of artefacts.

Isolated Finds. Isolated finds are generally identified as a single Aboriginal artefact with no association with any other archaeological evidence. As with artefact scatters isolated finds are likely to be found anywhere in the landscape. Although having no analytical value on their own, when used as part of a regional assemblage isolated finds can add to our knowledge of prehistoric Aboriginal use of the region. The definition of what constitutes an isolated find has generally been seen as a single artefact at a certain distance from another archaeological manifestation. The distance has varied with 50 metres, 60 metres, or 100 metres being used. During the present study an isolated find is defined as an artefact that has no apparent association with any other archaeological material. For example if two artefacts are located 90 metres apart

but are within the same geographical or topographical location (eg a saddle, or on the crest of a knoll) they are considered to be in association. Isolated finds are seen as either a random discard/loss of an item, or more commonly as an indication of the possibility that other cultural heritage material will be present.

Burial Sites. Burial sites are normally found in areas with soft easily dug deposits such as sand bodies. Another locality where burials may be found is in niches within rockshelters, and other suitable fissures in other rock outcrops. The survival of remains is dependent on a suitable environment being present. It is believed that the highly disturbed nature of the present study area would preclude the finding of burials.

Rockshelters with/without Archaeological Deposit. Rockshelters (or caves) occur where suitable rock outcrops are present. The presence or absence of surface artefacts determines the decision of whether a shelter has or has not archaeological deposit. If the shelter has some deposit within it, but no artefacts it is generally referred to as have Potential Archaeological Deposit. Rockshelters also may or may not have art sites within them. Based on the geology of the present study area it is highly unlikely for rockshelter sites to be located in the study area boundaries.

Art Sites (Pecked and Pigment). Art sites are rare, but present, within the Canberra-Queanbeyan region. The sites will be found where a suitable surface is present for such artwork to be carried out. Pigment art sites consist of varied images painted on the rock surface using pigments of various colours and materials. Pecked art is carried out by removal of the outer surface of rock to form an image, or motif. The pecked art sites can be found on either horizontal or vertical surfaces. Such sites will be highly unlikely to be found in the present study area.

Quarries/Stone Procurement Sites. Quarries are locations at which Aboriginal people obtained the stone raw materials required to manufacture tools and other pieces of equipment. These sites occur only where suitable rock outcrops occur, and can be represented by pebble beds in streams. It is possible that such sites will be present in the study area.

Grinding Groove Sites. These sites are places where some form of grinding was carried out. Such grinding may have been associated with the sharpening of ground edge axes, sharpening of spears, food preparation etc. Again they are normally only found in areas where suitable rock outcrops. Grinding groove sites are normally found on, but not necessarily restricted to, sandstone slab outcrops. Portable grinding slabs are possible in the study area.

Other Site Types. Other sites that may be expected in the region include scarred trees, freshwater middens, ceremonial sites (commonly referred to as Bora Rings), stone arrangements, and carved trees. The survival of these site types can have been compromised by past European land use practices. The presence of such sites can be reinforced by the presence of features such as major rock outcrops that may have had some social or "religious" significance (cf Knight 2001). These types of site are not expected to be present within the study area.

Aboriginal Scarred Trees/Carved Trees.

Aboriginal scarred trees are the result of the removal of bark or timber by Aboriginal people. Carved trees are the result of motifs being carved into trees following the removal of bark, and are normally associated with ceremonial grounds and burials. The identification of Aboriginal carved trees is much easier than that for Aboriginal scarred trees. Trees can have their bark removed by several processes other than by Aboriginal people. These processes include the removal in historical times by European settlers and land managers, and include removal of the bark for use in slab huts and temporary shelters. Natural phenomena that result in scars on trees include: branches falling off and stripping bark; lightning strike; damage from other trees falling;

animal disturbance of the bark; fires; and insect attack. Because of the problems in identifying with certainty if a tree is of Aboriginal origin or not the following criteria are used to assess the tree (cf Irish 2004):

- Aboriginal scars do not normally extend to the ground.
- If the scar does extend to the ground, to be identified as of Aboriginal origin the sides of the scar need to be parallel, or relatively parallel.
- Sides of scar are either parallel or concave, and symmetrical.
- Scar should be regular in outline and with regular regrowth.
- The ends of the scars should have a definite shape – pointed, rounded or squared off.
- If the scar has axe or adze marks it is considered as being of human origin. There is a difference between the marks made by an Aboriginal stone axe and a European steel axe. In the later the cuts are much sharper and more clearly defined. If a steel axe was used it does not discount an Aboriginal origin.
- The tree must be considered old enough to have been modified by Aboriginal people. Generally an age of about 150 years is considered appropriate.
- The tree must be endemic to the region. This excludes historic plantings.

Despite the presence of any or all of the above features it is possible that a scar is of natural origin. It is left to the person recording the tree to determine if it is of Aboriginal origin or not. To assist in the identification, several different categories are used to describe Aboriginal scars. These are:

- **Definite Aboriginal Scar** – conforms to all above criteria and can be supported by other information such as carvings, historical association, and definite adze marks.
- **Aboriginal Scar** – It is considered most likely that the scar is of Aboriginal origin.
- **Probable Aboriginal Scar** – It is considered that the scar is most likely of Aboriginal origin, but other causes cannot be easily discounted.
- **Possible Aboriginal Scar** – The scar has some or all of the above criteria but it is more likely that the tree was caused by natural phenomena.

Determining the Age of Scars. It is the consultant's experience that a reliable indicator of the age of a scar on a tree is the depth of regrowth of the bark. This regrowth can also be referred to as the lateral growth of the bark covering. Based on limited research in southern NSW and the ACT it would appear that for a scar to be old enough to be of Aboriginal origin the depth of regrowth would need to be at least 220 mm and possibly as high as 240 mm. The consultant has carried out limited research using scars of a known date - that is surveyor's marks on trees, to determine the figure. The model appears to hold for all environments investigated so far.

6. KNOWN CULTURAL HERITAGE OF STUDY AREA

Introduction

As discussed earlier there have been at least three cultural or archaeological assessments carried out within the Dunns Creek Road corridor. These studies have resulted in a large number of Aboriginal or European cultural heritage sites being recorded. The majority are at the western end of the study area near Old Cooma Road. For ease of discussion the study area has been divided into two section s, with the dividing line between the two being Jerrabomberra Creek.

Aboriginal Cultural Heritage Sites

Western Section. On the western side of Jerrabomberra Creek there is only one identified Aboriginal site. The site, TA 1, was recorded by survey teams from Navin Officer Heritage Consultants Pty Ltd (2003a). The site is a small low density artefact scatter consisting of two stone flakes which were located in a low gradient valley floor context. The site is within the southern section of the Tralee Development Area. Navin Officer recommended a program of archaeological test pitting if the area is to be disturbed by development. In addition to the single artefact scatter Navin Officer also recorded an area of Potential Archaeological Deposit (PAD) along the margins of Jerrabomberra Creek. The PAD is outside the Dunns Creek Road Corridor lying about 2 km to the north east.

Eastern Section. By far the largest number and concentration of Aboriginal archaeological sites is in the eastern section between Jerrabomberra Creek and Old Cooma Road (see Table 2 for details). This area was extensively surveyed by Navin Officer (2003b)(see Fig ?). Smaller archaeological surveys had previously been conducted over part of the area (Lewis 1984) during investigations for a proposed development at Jerrabomberra Park. Between them these surveys have resulted in eight Aboriginal cultural heritage sites being recorded. In addition Navin Officer (2003b) recorded nine PADs. Of these, four were considered important enough for them to remain undisturbed by development. If not then all nine PADs will need to be further investigated.

Table 2: Aboriginal Cultural Heritage Sites within Road Corridor

Site Name	Recorder	Location	Site Type/Number of Artefacts
SQBN W2	Lewis 1984		
SQBN W3	Lewis 1984		
TA 1	Navin Officer 2003a	696478 6080035	OS (n=2)
GA 8	Navin Officer 2003b	GDA 0700358 6078572	IF
GA 9	Navin Officer 2003b	GDA 0699599 6078580	IF
GA 10	Navin Officer 2003b	GDA 0701410 6078988	OS (n=12+)
GA 11	Navin Officer 2003b	GDA 0701211 6078745	OS (n=3)
GA 12	Navin Officer 2003b	GDA 07019828 6079086	OS (n=3)
GA 30	Navin Officer 2003b	GDA 0703163 6079013	OS (n=3)

European Cultural Heritage Sites

Western Section. At the time of writing there have been few European heritage sites recorded on the western side of Jerrabomberra Creek. In the Tralee study area Navin Officer (2003b) recorded nine European sites. Of these four lie within the Dunns Creek Road corridor (see Table 3). The remaining five lie outside the northern boundary. If a suitable route option is selected only one site the old Tralee Landing Ground (Site H9) will be impacted. Based on observations, either from visits to the area or overhead imagery, the landing ground appears to be highly disturbed.

Eastern Section. Within the eastern section of the Dunns Creek corridor three European heritage sites have been recorded (see Table 3). Of these three site, GH 8 and GH 9 appear to be the most important.

Table 3: Aboriginal Cultural Heritage Sites within Road Corridor

Site Name	Recorder	Location	Site Type/
H6	Navin Officer 2003a		Tralee Homestead Complex
H7	Navin Officer 2003a		Tralee Woolshed
H8	Navin Officer 2003a		Sheep Dip
H9	Navin Officer 2003a		Tralee Landing Ground
GH 8	Navin Officer 2003b	GDA 0701227.6079259	Hearth and Platform Portion 99
GH 9	Navin Officer 2003b	GDA 0701056.6078780	'Copperfields' Portion 99
GH 10	Navin Officer 2003b	GDA 0701814. 6078911	Tractor (Travelling Stock Reserve 27)

Potential Archaeological Deposits

During their archaeological surveys of both Tralee (Navin Officer 2003a) and Googong (Navin Officer 2003b) Development areas Navin Officer recorded a number of areas identified as PADs. A PAD is an area that has no cultural heritage material recorded in it but it is likely for that material to be there. These areas were selected based on the Aboriginal site location models for the Jerrabomberra area and on the researcher's experience. In all cases Navin Officer (2003a; 2003b) recommended further investigations (ie sub-surface investigations) prior to any development work in the area. Within the eastern section they identified four that were considered important enough (PADs 3, 4, 6, and 7) that they should be avoided. The PADs recorded in the road corridor are outlined in Table 4.

Within Table 4 are three PADs that are outside the Dunns Creek Road corridor. They are included for a number of reasons, including:

- They are close to the boundaries of the corridor (GPAD 23 and 24)
- They are considered relevant to discussion (especially PAD 1 at Tralee).

Prior to any development work taking place in any of the PAD areas it has been recommended by the various report authors that further investigation should take place. This is especially so for the four mentioned above (PADs 3, 4, 6, and 7).

Analysis of the survey routes examined by Navin Officer (2003b) during their work in the Googong Development Area indicates that the surveyors inspected the margins of Jerrabomberra

Creek. It is noteworthy that along the southern part of the creek (within the corridor) that no PADs were identified. This is considered an important point as the Navin Officer teams are generally experienced. That no PADs were recorded in the area, but were elsewhere along the creek (GPAD1 and 2, PAD 1 Tralee) suggests that the area is too disturbed or the terrain unsuitable for habitation. Based on image analysis the slopes are fairly steep in the area. It is suggested that this section of the creek, based on archaeological constraints, is the best option for Dunns Creek Road to cross Jerrabomberra Creek. Such a route can be selected to avoid all areas considered to potentially have cultural heritage material present.

Table 4: PADs within Road Corridor

Site Name	Recorder	Location	Recorders Recommendations
GPAD 1	Navin Officer 2003b	GDA 0699500.6078650	Further Investigations if disturbed
GPAD 2	Navin Officer 2003b	GDA 0699500.6078900	Further Investigations if disturbed
GPAD 3	Navin Officer 2003b	GDA 0700500.6079550	Avoid Development if Possible
GPAD 4	Navin Officer 2003b	GDA 0700825.6079400	Avoid Development if Possible
GPAD 5	Navin Officer 2003b	GDA 0701200. 6078750	Further Investigations if disturbed
GPAD 6	Navin Officer 2003b	GDA 0701400.6079150	Avoid Development if Possible
GPAD 7	Navin Officer 2003b	GDA 0701675.6078650	Avoid Development if Possible
GPAD 23	Navin Officer 2003b	GDA 0701075.6076850	Further Investigations if disturbed
GPAD 24	Navin Officer 2003b	GDA 07007506078000	Further Investigations if disturbed
PAD 1 (Tralee)	Navin Officer 2003a	697835 6081200	Further Investigations if disturbed

7. SIGNIFICANCE ASSESSMENT

Introduction

The *Burra Charter of Australia* defines cultural significance as the "… aesthetic, historic, scientific, or social value for past present and future generations (Marquis-Kyle and Walker 1992:69)." Generally the cultural significance of Aboriginal sites is assessed using the following criteria:

- its significance to contemporary Aboriginal people
- its scientific (or archaeological) value (including representativeness);
- aesthetic value;
- historic value; and
- education value;

Determining Aboriginal Significance

Many areas will be significant according to several of the above category. Despite this Aboriginal open campsites are generally only assessed based on their significance to contemporary Aboriginal people; and their scientific value. It has been found that Aboriginal communities value the cultural heritage material found during surveys. Most see such material as a link with the past, a link with their ancestors. The level of significance placed on the Aboriginal sites recorded during the present study is an issue for the local Aboriginal communities to determine. The Aboriginal significance of the sites within the Dunns Creek Road Corridor has not been identified as such action is outside the scope of the present study. Prior to any construction activity the Aboriginal significance will need to be determined through consultation and discussion with representatives of the local Aboriginal community.

Determining Archaeological Significance – Aboriginal Sites

There are two criteria generally used in assessing the scientific significance of artefact scatters: firstly the potential of a site or place to provide information which is of value in the scientific analysis of potential research questions. This is generally seen as being in sites that are relatively undisturbed with *insitu* archaeological material and that are still in good condition. The second criterion is the representativeness of a place. Representativeness is the measure of the degree a place is characteristic of its type, content or location. A place may also be significant under this criterion if it is rare or provides a good example of such a place.

When assessing the Archaeological Significance of an Aboriginal place or site, that assessment is normally carried out at three levels: local, regional, and state. A site can be deemed to have high local significance, but low regional and state significance.

Archaeological Significance Assessment – Aboriginal Sites within Study Area

The level of archaeological significance for the Aboriginal sites within the Dunns Creek Road Corridor is that which has been determined by the recorder or the site. The individual assessments are outlined in Table 5. The present writer does not necessarily endorse the assessed significance levels.

Based on the level of disturbance within the study area the Archaeological Significance Assessment of the known Aboriginal archaeological sites and cultural heritage material has been generally assessed across the entire range from Low to High on a local level, and Low to

moderate on a regional level. It should be said however that the type of artefacts and the type of sites recorded during the study are common throughout not only the Canberra-Queanbeyan area but NSW and Australia. The artefacts types and raw materials used are typical of those found in the region. It is the consultants opinion that the main value that the sites have is when used at a regional level to determine the level of Aboriginal exploitation. That the artefacts and sites have been recorded fulfils this role. None of the sites has any archaeological significance at a state level.

Table 5: Archaeological Significance Level of Aboriginal Sites Recorded known to be in the Dunns Creek Road Corridor

Site Name	Site Type	Regional Significance	Local Significance
TA 1	OS	Low	Low
GA 8	IF	Low	Low to Moderate
GA 9	IF (with PAD)	Low to Moderate	Low to Moderate
GA 10	OS	Moderate to High	High
GA 11	OS	Moderate	Moderate to High
GA 12	OS	Low	Moderate
GA 30	OS	Low	Low to Moderate
SQBN W2	OS	Low	Moderate
SQBN W3	OS (with PAD)	Moderate	moderate-high

Archaeological Significance Assessment – European Sites within Study Area

The heritage significance of European Heritage sites is outlined in Table 6. As with the Aboriginal sites the significance is that which has been placed on the item by the recorders of the sites. It is important to note that the three sites recorded by Navin Officer (2003b) in the Googong Development Area have moderate to high or high rating on a local level. The level of significance placed on the three items is explained by Navin Officer (2003b:98) .

> "In the case of site complexes … this assessment applies to the site as a whole, individual features of the site may in some cases have higher or lower significance than that of the complex. … (s)ite complexes may be of particular significance since they have the potential to convey more comprehensive interpretive value."

(The significance level for the items in Tralee is still being sought).

Table 6: Archaeological Significance Level of European Sites Recorded known to be in the Dunns Creek Road Corridor

Site Name	Site Type	State Significance	Local Significance
GH 8	Hearth and Platform Portion 99	Low to Moderate	Moderate to High
GH 9	'Copperfields' Portion 99	Moderate	High
GH 10	Tractor (Travelling Stock Reserve 27)	Low to Moderate	Moderate to High
H6	Tralee Homestead Complex	Not Known	Not Known
H7	Tralee Woolshed	Not Known	Not Known
H8	Sheep Dip	Not Known	Not Known
H9	Tralee Landing Ground	Not Known	Not Known

9. LEGISLATIVE OBLIGATIONS

Introduction

At the State level Aboriginal cultural heritage is specifically afforded legislative protection in New South Wales under the following legislation:

- *National Parks and Wildlife Act (1974) (As Amended)*; and
- *Environmental Planning and Assessment Act 1979*.

National Parks and Wildlife Act

In NSW Aboriginal cultural heritage is afforded legislative protection under Part 6 of the National Parks & Wildlife Act. The Act makes provision for the protection of Aboriginal *relics* throughout NSW and allows for the responsible Minister to declare places of special significance with respect to Aboriginal culture to be an *Aboriginal place* for the purpose of the Act.

Under Section 90 it is an offence to knowingly destroy, deface or damage a *relic* or Aboriginal place without having first obtained the consent of the Director General of the NSW DEC. Section 90 is applicable to all Aboriginal *relics* across NSW regardless of land tenure.

Environmental Planning and Assessment Act

Indirect protection of Aboriginal heritage is afforded by the *Environmental Planning and Assessment Act 1979* through a requirement to consider the potential environmental impacts, including impacts upon Aboriginal heritage, of certain activities including construction and development activities.

Whilst this protection is associated with specific activities rather than more general or blanket protections. It does result in the consideration of potential impacts upon Aboriginal heritage through the requirement for impact assessment. Aboriginal heritage places and values identified during this assessment process can then be more readily managed under the provisions of the *National Parks & Wildlife Act*.

10. CONCLUSIONS

Conclusions

Despite the high levels of disturbance across the Dunns Road Corridor significant cultural heritage material and sites, both Aboriginal and European are present. The level of cultural heritage significance placed on these places and items varies. In the main they have a fairly high rating on a local level. In addition to the sites a number of PADs have been recorded in the area. All, as with the vast majority of Aboriginal sites, are located on the eastern side of Jerrabomberra Creek. Of these it has been recommended that four be avoided during development of the area. These four PADS are assessed has having potential archaeological significance. It has also been recommended that if these areas are to be disturbed, then they, as with the other PADs, should have further investigation, including sub-surface investigations carried out.

Based on the results of the present study, and the data collected from previous studies in or near the Dunns Creek Road Corridor, it is possible to identify, not a preferred route, but a narrower corridor. This corridor is identified in an effort to avoid interference with a large number of cultural heritage sites, both Aboriginal and European.

Essentially the "narrower" corridor occupies the southern part of the larger corridor. The route can leave the Monaro Highway at the roundabout as indicated and takes a southerly route before connecting with Old Cooma Road (see Fig 3) joining that road at or to the south of the roundabout at Googong Road.

Management Options

Based on the known cultural heritage inventory of the study area there is essentially one management option. This is to avoid the main complex of Aboriginal and European archaeological sites and adopt a route confined to the southern part of the road corridor. It will however be necessary at a later stage to conduct further assessments of any route proposed. It is highly recommended that any route as much as possible, and considering other factors, should avoid the known sites (see Fig 3).

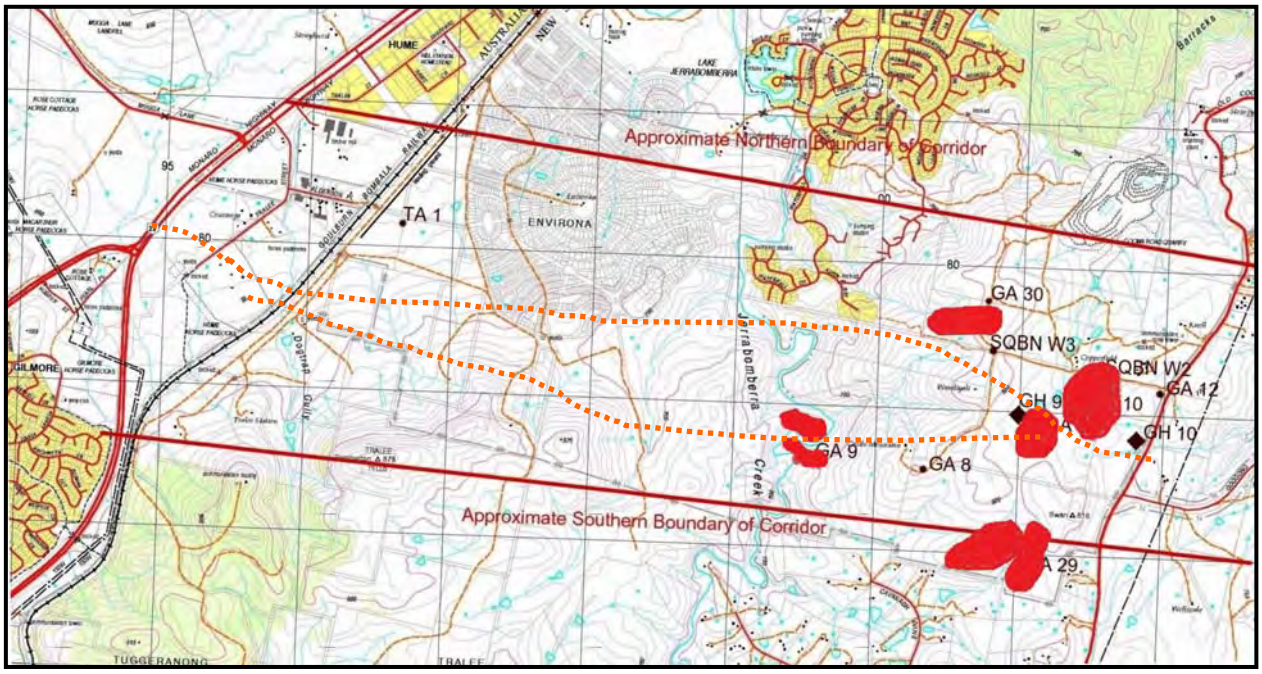


Fig 3: Preferred (approximate) road alignments. The routes (orange dotted lines) have been selected to avoid known Aboriginal and European cultural heritage sites and areas of PAD (red patches).

Recommendations

Based on the results of the investigations carried out as part of this study and on the legislative obligations outlined in the relevant legislation it is recommended that:

- The route selected avoid as much as possible any previously recorded Aboriginal or European heritage sites, especially those with a high rating or which are complex sites.
- On cultural heritage grounds (both Aboriginal and European) the best route options are located towards the southern boundary of the Dunns Creek Road Corridor. The route can leave the roundabout on the Monaro Highway and terminate at, or to the south of, the junction of Old Cooma Road and Googong Road.
- Alternate northern route options be considered only if the southern route options are unsuitable on other grounds such as ecological, geological, and topographical constraints.
- Once the individual route options have been identified, as part of the final selection process, those routes should be subjected to archaeological investigation/survey. This includes within the areas that have already been surveyed.
- If the route will impact on any of the previously identified cultural heritage sites, including PADs further research in those areas will need to be conducted. This may include sub-surface investigations.
- Such surveys and investigations where they involve Aboriginal sites should be carried out in conjunction with representatives of the local Aboriginal community.
- At all stages during the process of final route selection the local Aboriginal community must be consulted and involved in the process.

Copies of this report should be sent to:

Senior Aboriginal Heritage Officer
South Branch, Environment Protection and Regulation Division
Department of Environment and Climate Change (NSW)
PO Box 2115
QUEANBEYAN NSW 2650

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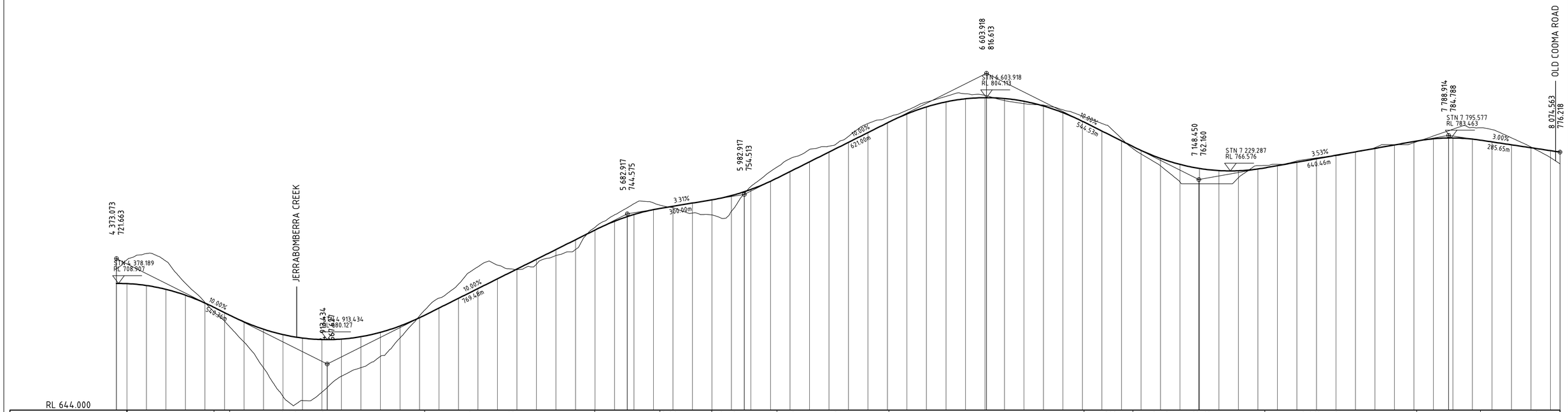
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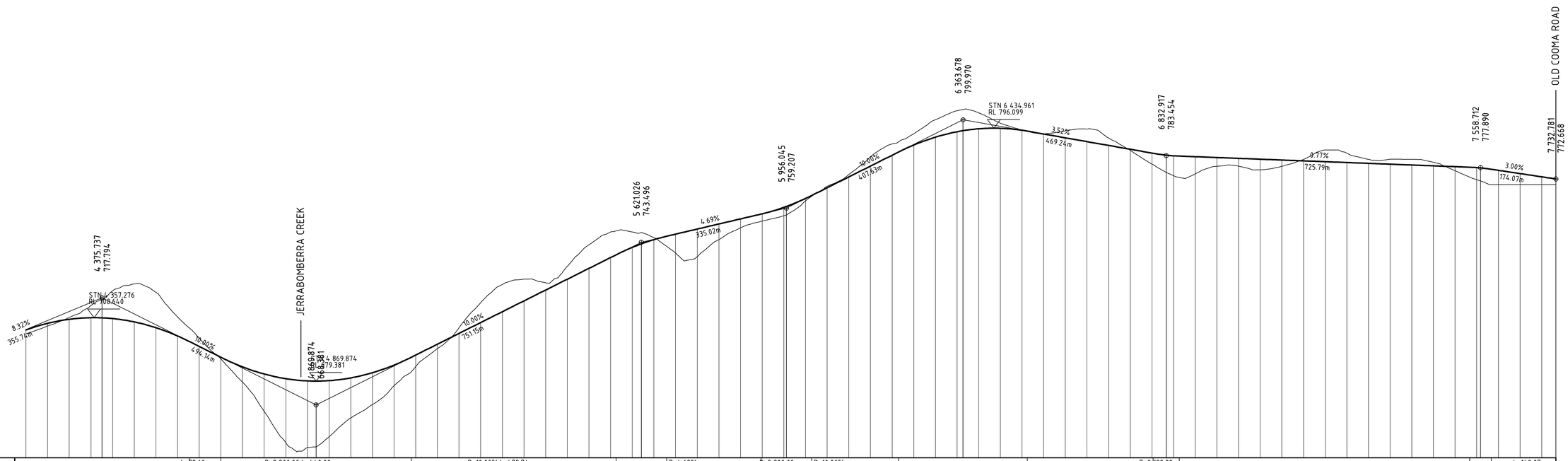
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Appendix E

Initial Alignment Options

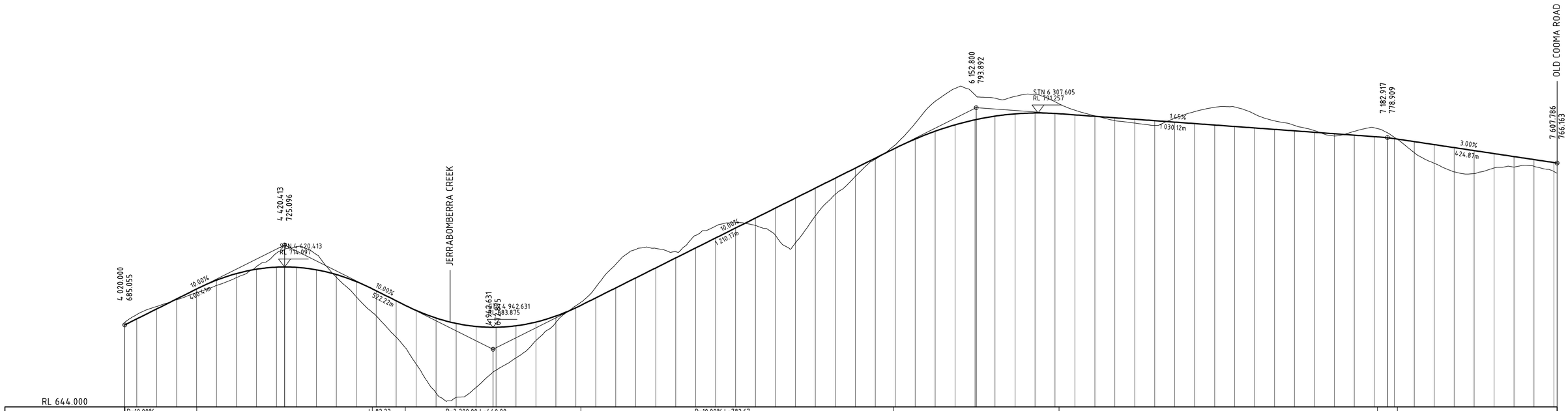

4 373.073
721.663
STN 4 378.189
RL 708.907
10.00%
520.36m
JERRABOMBERRA CREEK
4 913.434
680.127
10.00%
769.48m
5 682.917
744.575
3.31%
300.00m
5 982.917
754.513
10.00%
621.00m
6 603.918
816.613
STN 6 603.918
RL 804.713
10.00%
544.53m
7 148.450
762.160
STN 7 229.287
RL 766.576
3.53%
640.46m
7 788.914
784.788
STN 7 795.577
RL 783.463
3.00%
285.65m
8 074.563
776.218
OLD COOMA ROAD
RL 644.000

| | | |


4 375.737
717.794
STN 4 357.276
RL 708.640
8.32%
355.74m
10.00%
494.14m
JERRABOMBERRA CREEK
4 869.874
4 869.874
669.381
5 621.026
743.496
4.69%
335.02m
5 956.045
759.207
10.00%
407.63m
6 363.678
799.970
STN 6 434.961
RL 796.099
3.52%
469.24m
6 832.917
783.454
0.77%
725.79m
7 558.712
777.890
3.00%
174.07m
7 732.781
772.668
OLD COOMA ROAD

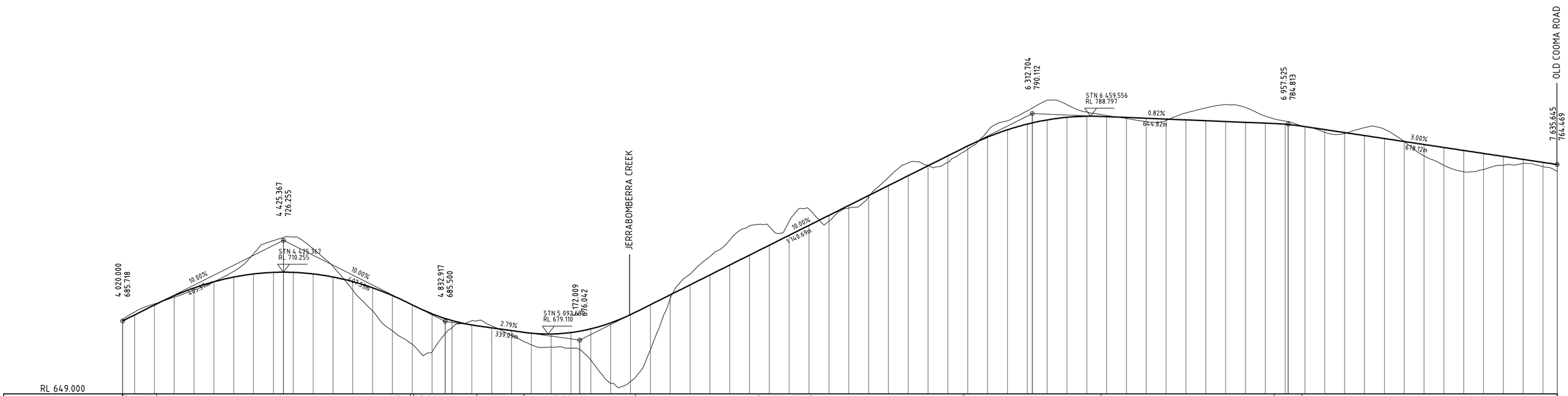
RL 644.000

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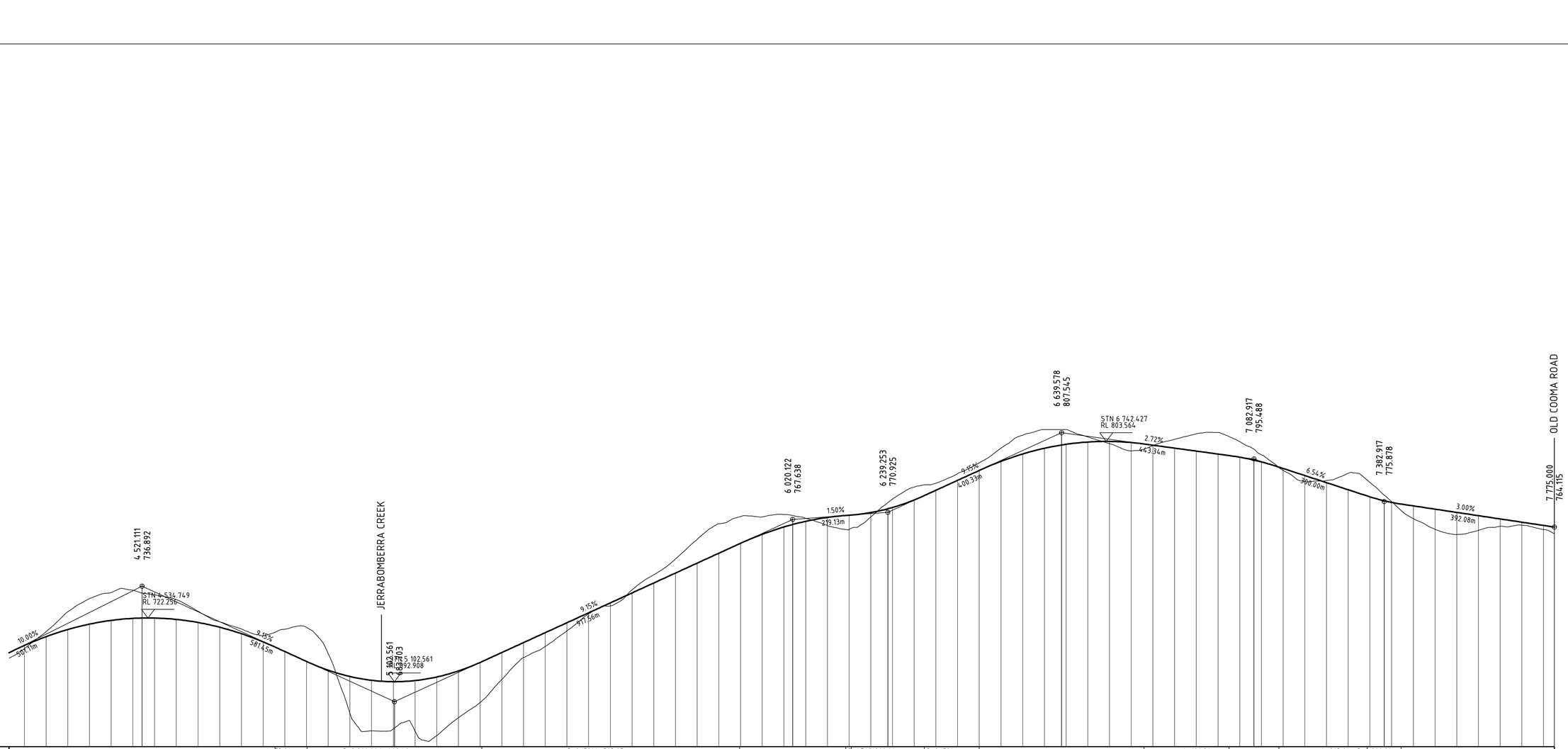

4 020.000
685.055
4 420.413
725.096
STN 4 420.413
RL 776.097
10.00%
400.41m
10.00%
592.22m
JERRABOMBERRA CREEK
4 942.631
683.875
6 152.800
793.892
STN 6 307.605
RL 791.257
10.00%
1 210.17m
1.45%
1 030.12m
7 182.917
778.909
3.00%
424.87m
7 607.786
766.163
OLD COOMA ROAD

RL 644.000

| | | |


4 020.000
685.718
10.00%
195.51m
4 425.367
726.255
STN 4 425.367
RL 710.255
10.00%
195.51m
4 832.917
685.500
2.79%
339.09m
STN 5 092.688
RL 679.110
5 172.009
676.042
JERRABOMBERRA CREEK
10.00%
1140.69m
6 312.704
790.112
STN 6 459.556
RL 788.797
0.82%
644.82m
6 957.525
784.813
3.00%
678.12m
7 635.645
764.469
OLD COOMA ROAD
RL 649.000

| | | |



RL 663.000

VERTICAL ALIGNMENT	R=-3 200.00 L=612.72 · L=73.84 P=-9.15% · R=2 200.00 L=402.49 · P=9.15% L=593.95 · R=-3 200.01 L=244.72 L=12.65 · R=2 200.01 L=168.25 · P=9.15% L=126.33 · R=-3 200.01 L=379.75 · L=196.21 P=-2.72% · R=-2 999.98 L=114.51 · L=203.84 P=-6.54% · R=2 200.00 L=77.81 · P=-3.00% L=353.18
HORIZONTAL ALIGNMENT	R=400.00 · R=INFINITY · R=-400.00 · R=INFINITY · R=-1 850.39 · R=INFINITY · R=800.00 · R=INFINITY

STATION	PROPOSED R.L.	EXISTING R.L.
4 250.000	709.586	708.116
4 300.000	713.645	715.906
4 350.000	716.922	725.079
4 400.000	719.418	731.197
4 450.000	721.133	733.971
4 500.000	722.067	735.032
4 550.000	722.219	732.866
4 600.000	721.590	730.673
4 650.000	720.180	725.373
4 700.000	717.989	720.488
4 750.000	715.016	717.158
4 800.000	711.262	714.001
4 850.000	706.806	717.053
4 900.000	702.232	717.912
4 950.000	698.197	705.810
5 000.000	695.298	678.436
5 050.000	693.536	670.269
5 100.000	692.909	671.187
5 150.000	693.419	670.257
5 200.000	695.065	668.098
5 250.000	697.848	676.298
5 300.000	701.767	683.371
5 350.000	706.338	693.931
5 400.000	710.912	703.973
5 450.000	715.485	709.142
5 500.000	720.059	716.280
5 550.000	724.633	724.113
5 600.000	729.207	727.825
5 650.000	733.781	735.221
5 700.000	738.354	742.131
5 750.000	742.928	749.401
5 800.000	747.502	758.435
5 850.000	752.076	765.612
5 900.000	756.649	768.952
5 950.000	760.797	768.772
6 000.000	764.464	769.910
6 050.000	766.750	768.192
6 100.000	768.554	764.814
6 150.000	769.586	763.051
6 200.000	770.794	768.778
6 250.000	773.132	776.989
6 300.000	776.606	782.537
6 350.000	781.055	784.317
6 400.000	785.629	788.699
6 450.000	790.203	793.682
6 500.000	794.382	800.427
6 550.000	797.779	806.418
6 600.000	800.395	809.000
6 650.000	802.230	809.000
6 700.000	803.283	805.607
6 750.000	803.556	802.502
6 800.000	803.047	799.207
6 850.000	801.822	801.620
6 900.000	800.463	804.510
6 950.000	799.103	807.055
7 000.000	797.743	807.653
7 050.000	796.284	803.438
7 100.000	794.102	797.438
7 150.000	791.103	790.209
7 200.000	787.835	785.030
7 250.000	784.566	785.536
7 300.000	781.298	788.879
7 350.000	778.038	784.628
7 400.000	775.473	775.783
7 450.000	773.865	767.932
7 500.000	772.365	763.068
7 550.000	770.865	760.686
7 600.000	769.365	762.602
7 650.000	767.865	764.512
7 700.000	766.365	764.974
7 750.000	764.865	763.000

DUNNS CREEK OPTION5 - CONTROL LINE MC00

HORIZONTAL SCALE 1:5000
VERTICAL SCALE 1:1000

PRELIMINARY

No	Revision	Drawn	Checked	Approved	Date
A	PRELIMINARY	SH			

0 50 100 150 200 250m
HORIZONTAL SCALE 1:5000 AT ORIGINAL SIZE

0 10 20 30 40 50m
VERTICAL SCALE 1:1000 AT ORIGINAL SIZE

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DO NOT SCALE

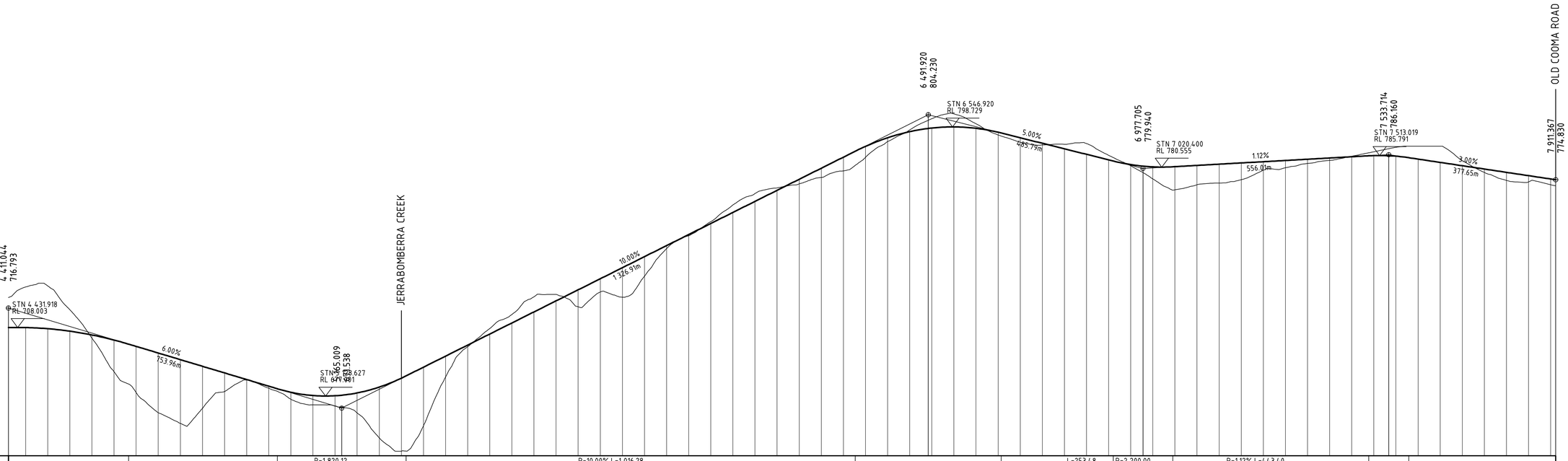
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Drafting Check		Design Check	
Approved			
Date			
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client QUEANBEYAN CITY COUNCIL
Project DUNNS CREEK ROAD ALIGNMENT STUDY
Title CONCEPT DESIGN
OPTION 5 - PROFILE

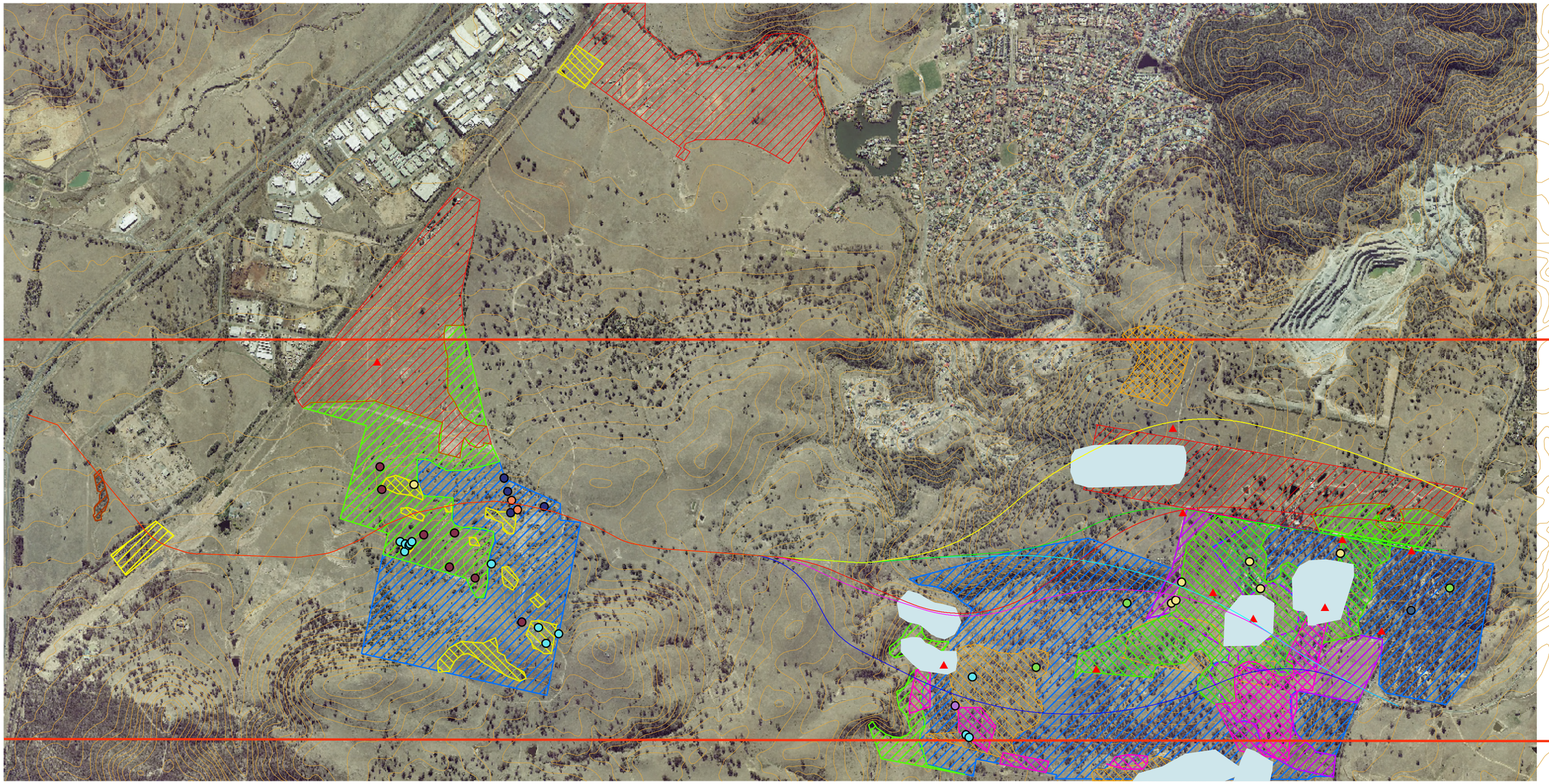
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Rev: A

Plot Date: 7 December 2007 - 11:21 AM
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4 411.044
716.793
STN 4 431.918
RL 708.003
6.00%
753.96m
STN 4 765.009
RL 677.538
STN 4 823.627
RL 674.081
JERRABOMBERRA CREEK
10.00%
1 326.91m
6 491.920
804.230
STN 6 546.920
RL 798.729
5.00%
485.79m
6 977.705
779.940
STN 7 020.400
RL 780.555
1.12%
556.01m
7 533.714
786.160
STN 7 513.019
RL 785.791
3.00%
377.65m
7 911.367
774.830
OLD COOMA ROAD

RL 650.000

| | | |



Heritage
- Heritage

ThreatenedSpecies
- Aprasia
- Brown Tree-creeper
- Diamond Fire Tail
- Golden Sun Moth
- Hooded Robin
- Leucochrysum albicans tricolor
- Perunga Ochracae
- Swainsona sericea

Ecological Community
- Remnant Yellow Box Red Gum Grassy Woodland
- Swainsona recta Secondary grassland Remnant Box Gum Woodland
- HeritagePADs
- RockOutcrop
- GoldenSunMothPotentialHabitat
- GoldenSunMothHabitat
- ApraisiaHabitat
- NonNativeGrasslandAgriculture
- NativeGrassland
- NaturalTemperateNativeGrassland
- BoxWoodlandForest

Initial Alignments
- Option 1
- Option 2
- Option 3
- Option 4
- Option 5
- Option 6

1:20,000

0 250 500 750 1,000

Metres (at A3)

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

LEGEND

SiteBoundary

Contour (10m interval)

Queanbeyan City Council
Dunn's Creek

Job Number	23-12266
Revision	A
Date	5 Dec 2007

Initial Alignments and Constraints

Figure D1

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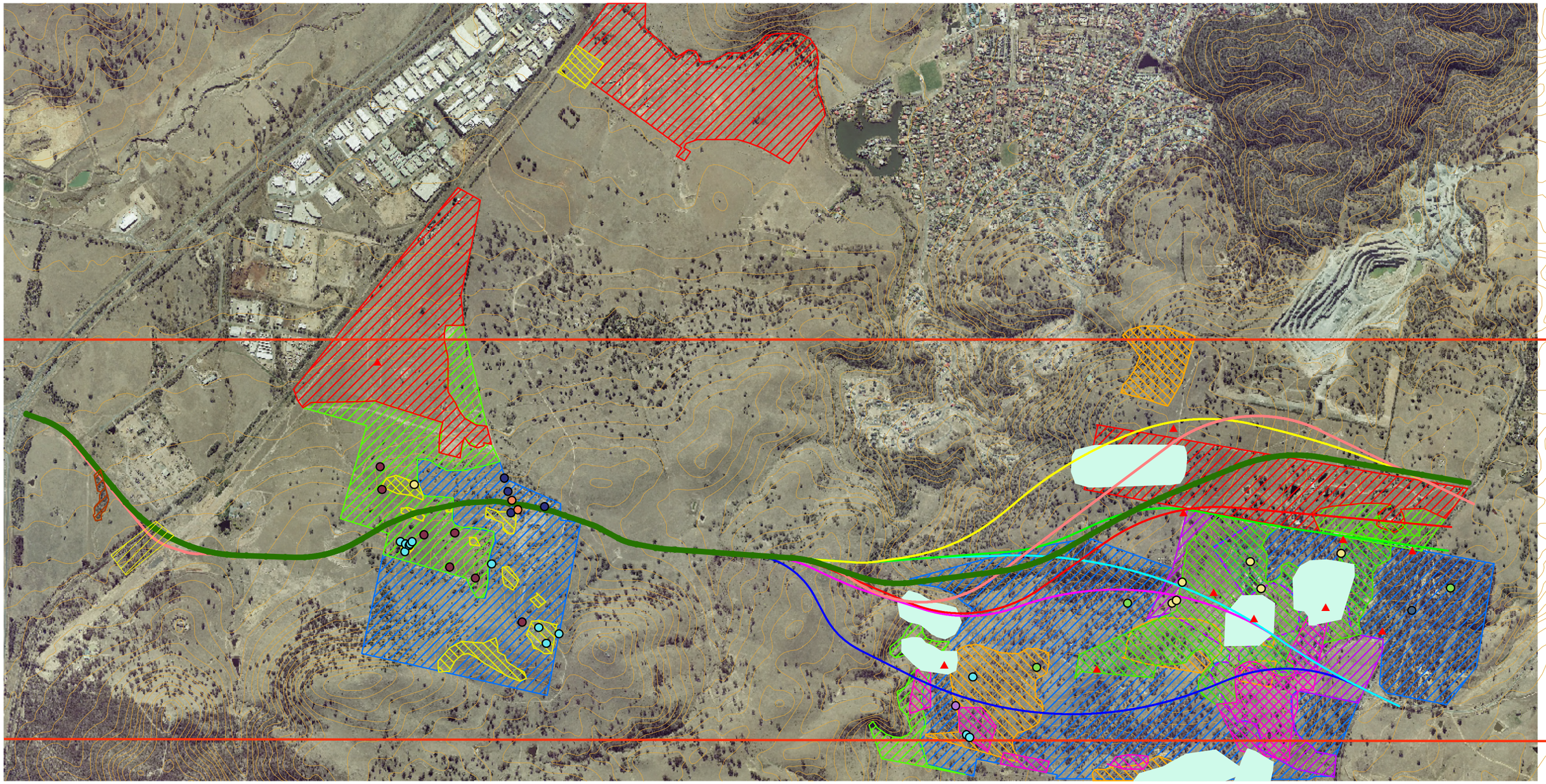
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Appendix F

Preferred Alignment



Heritage
- Heritage

ThreatenedSpecies
- Aprasia
- Brown Tree-creeper
- Diamond Fire Tail
- Golden Sun Moth
- Hooded Robin
- Leucochrysum albicans tricolor
- Perunga Ochracae
- Swainsona sericea

Ecological Community
- Remnant Yellow Box Red Gum Grassy Woodland
- Swainsona recta Secondary grassland Remnant Box Gum Woodland
- HeritagePADs
- RockOutcrop
- GoldenSunMothPotentialHabitat
- GoldenSunMothHabitat
- ApraisiaHabitat
- NonNativeGrasslandAgriculture
- NativeGrassland
- NaturalTemperateNativeGrassland
- BoxWoodlandForest

Alignment Options
- Option 1B (Preferred Route)
- Option 1A
- Option 1
- Option 2
- Option 3
- Option 4
- Option 5
- Option 6

1:20,000

0 250 500 750 1,000

Metres (at A3)

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

LEGEND
- SiteBoundary
- Contour (10m interval)

Queanbeyan City Council
Dunn's Creek

Job Number	22-12266
Revision	A
Date	5 Dec 2007

Preferred Alignments and Constraints

Figure E1

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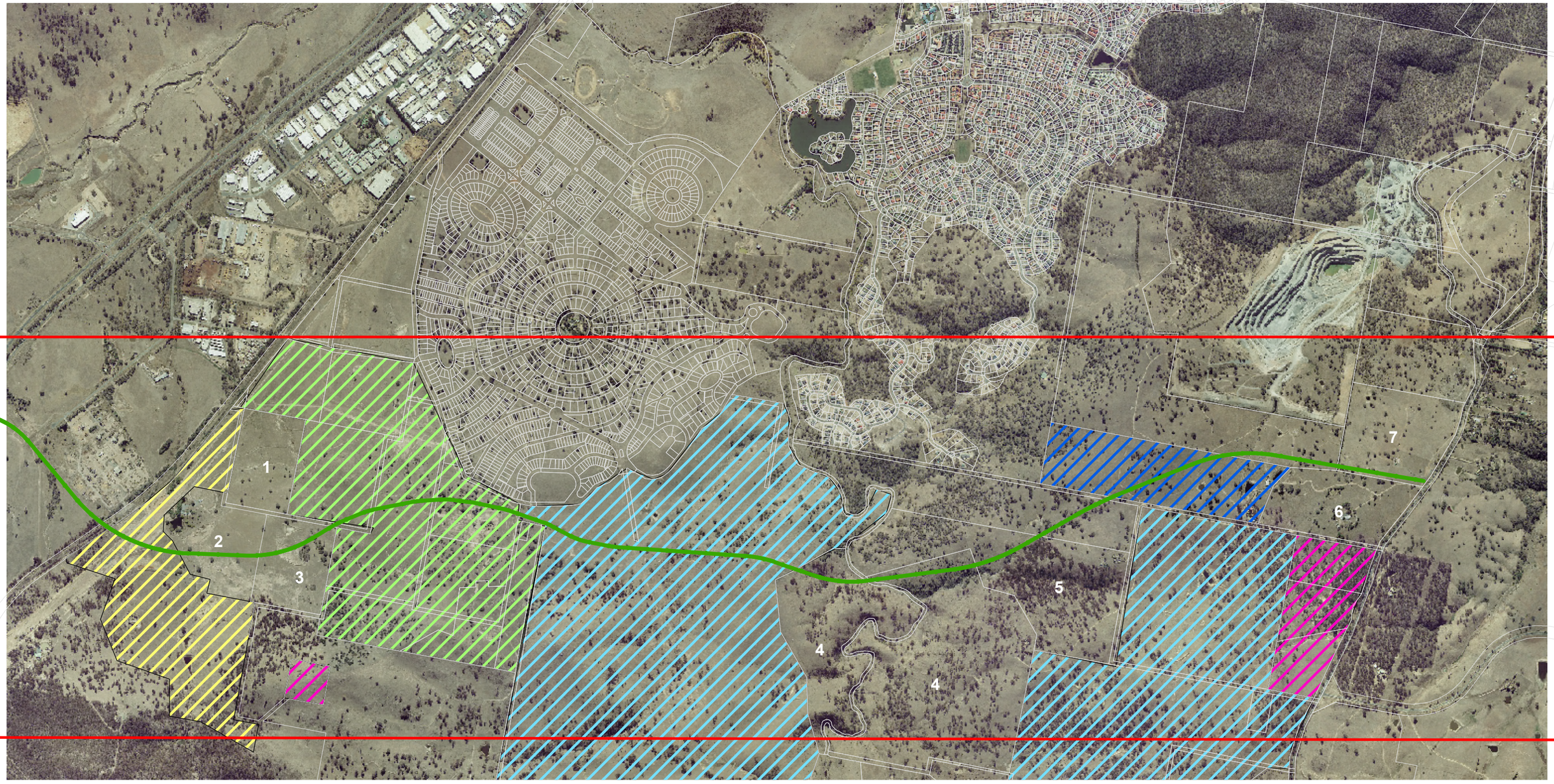
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Appendix G

Property Impacts

DRAFT



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

1:20,000

0 250 500 750 1,000

Metres (at A3)

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

LEGEND

SiteBoundary

Option 1B

Land Ownership

- Crown Land
- Rinker (Quarry)
- Robin Pty Ltd
- Tuggeranong Investments
- Village Building Company

Queanbeyan City Council
Dunn's Creek

Option 1B and
Property Boundaries

Job Number	22-12266
Revision	A
Date	5 Dec 2007

Figure F1

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Data source: Dept of Lands NSW: 2006; QCC: 2007. Created by: C Charalambou

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Appendix H

Geotechnical Report

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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.

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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 observe 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.

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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.

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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.

DRAFT

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			
Williamsdale (Transferral) Chainage 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.	◗ Seasonal waterlogging; ◗ Complex terrain; ◗ Flood hazard (localised); ◗ Run-on; ◗ Dieback.	**Type Profile 1 – Lower Slope** **Layer 1, A_1: 0 – 8 cm** wi1 Greyish yellow brown loam. **Layer 2, A_2: 8 – 16 cm** wi2 Dull yellow orange silty loam. **Layer 3, B_2: 16 – 58 cm** wi3 Bright yellowish brown light clay. **Type Profile 2 – Lower Slope** **Layer 1, A_1: 0 – 15 cm** wi1 Brownish black loam. **Layer 2, A_{2e}: 15 – 27 cm** wi4 Dull yellow brown silty loam. **Layer 3, B_2: 27 – 90 cm** wi5 Yellowish brown light-medium clay. **Type Profile 3 – Low Rises** **Layer 1, A_1: 0 – 8 cm** wi6 Dark reddish brown clay loam. **Layer 2, B_2: 8 – 16 cm** wi7 Dark red light-medium clay.	**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 – Lanscape variant lub (Transferral) Chainage 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 to 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.	◗ Complex terrain (localised); ◗ Mass movement hazard; ◗ Run-on (localised); ◗ Seasonal waterlogging (localised); ◗ Sheet erosion risk; ◗ Engineering hazard (localised).	**Type Profile 1 – Lower Slope** **Layer 1, A_1: 0 – 18 cm** Lu1 Brownish black sandy loam. **Layer 2, A_2: 18 – 50 cm** Lu2 Dull yellowish brown sandy loam. **Layer 3, B_2: 50 – 68 cm** Lu3 Bright brown light clay. **Layer 4, B: 68 – 156 cm** **Massive pan.** **Layer 5, $2B_2$: 156 – 190 cm** Lu4 Bright yellowish brown light clay.	**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**

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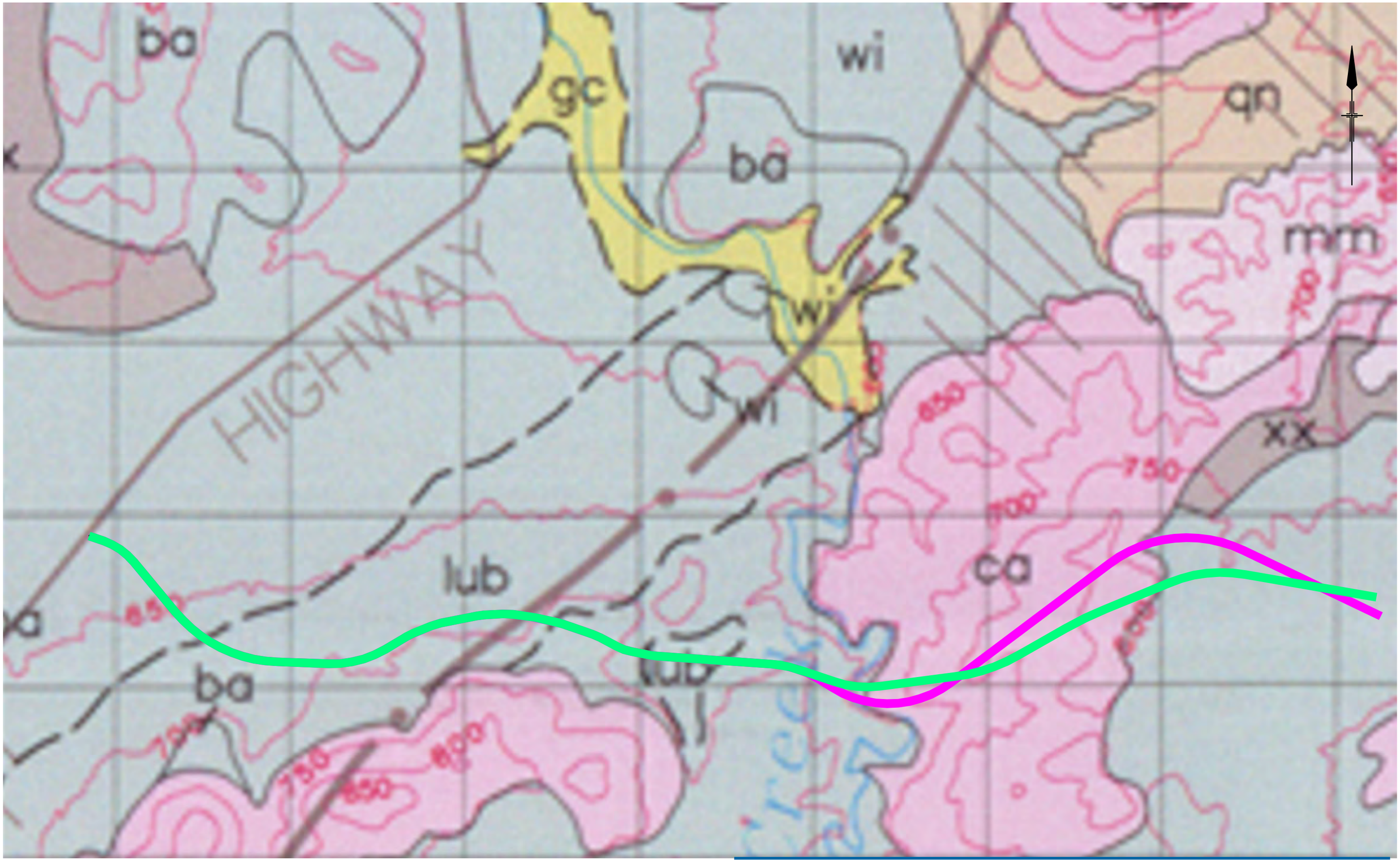
Soil Landscape	Geology	Landscape	Land Degradation	Included Soil Landscapes	Landscape Limitations	Soils	Erodibility			
Campbell (Colluvial) Chainage 4800 - 6400	Silurian volcanics and sediments of the Canberra Block. The complicated lithology includes various tuffs, siltstones, sandstone, rhyolites, dacites 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.	◗ Steep Slopes; ◗ Engineering Hazard; ◗ Moderate mass movement hazard; ◗ Springs (permanently high watertables); ◗ Sheet erosion risk; ◗ Shallow soils; ◗ Run-on (lower slopes and drainage lines); ◗ Rock outcrop.	**Type Profile 1 - Midslope** **Layer 1, A_1: 0 – 10 cm** Ca1 Brownish black loam. **Layer 2, A_2: 10 – 18 cm** Ca2 Dark brown loam. **Layer 3, B_2: 18 – 48 cm** Ca3 Dull reddish brown light clay. **Type Profile 2 – Open depression** **Layer 1, A_1: 0 – 6 cm** Ca1 Greyish yellow brown loam. **Layer 2, A_2: 6 – 28 cm** Ca2 Dull yellow orange sandy clay loam. **Layer 3, B_2: 28 – 120 cm** Ca4 Bright brown light-medium clay.	Ca1	Moderate	High	Very Low
							Ca2	High	High	Very Low
							Ca3	High	Very High	Very Low
							Ca4	Moderate	High	Low
Burra (Transferral) Chainage 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	◗ Sheet erosion risk; ◗ Localised Shallow soils; ◗ Localised Run-on; ◗ Dieback.	**Type Profile 1 – Upper Slope** **Layer 1, A_1: 0 – 8 cm** Ba1 Dark brown loam. **Layer 2, A_{2e}: 8 – 28 cm** Ba2 Dull yellow orange silty loam. **Layer 3, B_2: 28 – 84 cm** Ba3 Dark reddish brown medium-heavy clay. **Type Profile 2 – Midslope** **Layer 1, A_1: 0 – 6 cm** Ba1 Brownish black sandy loam. **Layer 2, A_{2e}: 6 – 28 cm** Ba5 Dull yellow sandy clay loam. **Layer 3, B_2: 28 – 120 cm** Ba4 Yellowish brown medium clay.Ba2 Dull yellow sandy clay loam. **Layer 3: 28 – 120 cm** Ba4 Yellowish brown medium clay.	Ba1	Moderate	Moderate	Low
							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.

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DUNNS CREEK ROAD ALIGNMENT STUDY
SOIL LANDSCAPE MAP

job no. 23-12266
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Figure E1

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

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

Plot Date: 07 December, 2007 - 9:33 AM Cad File No: G:\23\12266\CADD\Drawings\ 23-12266-FIG_E1.dwg

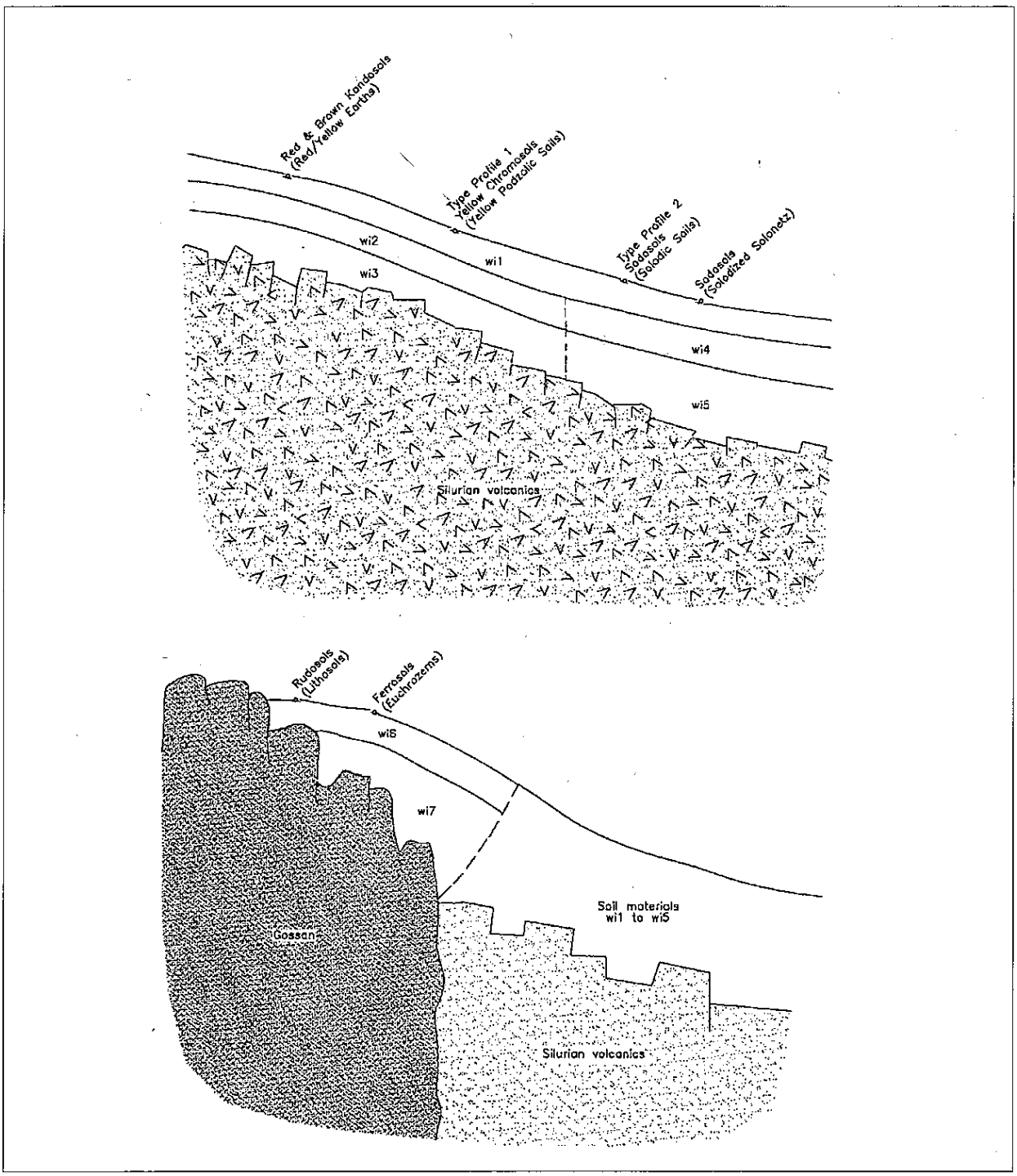


Figure G2 Distribution Diagram of Williamsdale Soil Landscape Illustrating Occurrence and Relationship of Dominant Soil Materials (source: Jenkins, B.R. 2000)

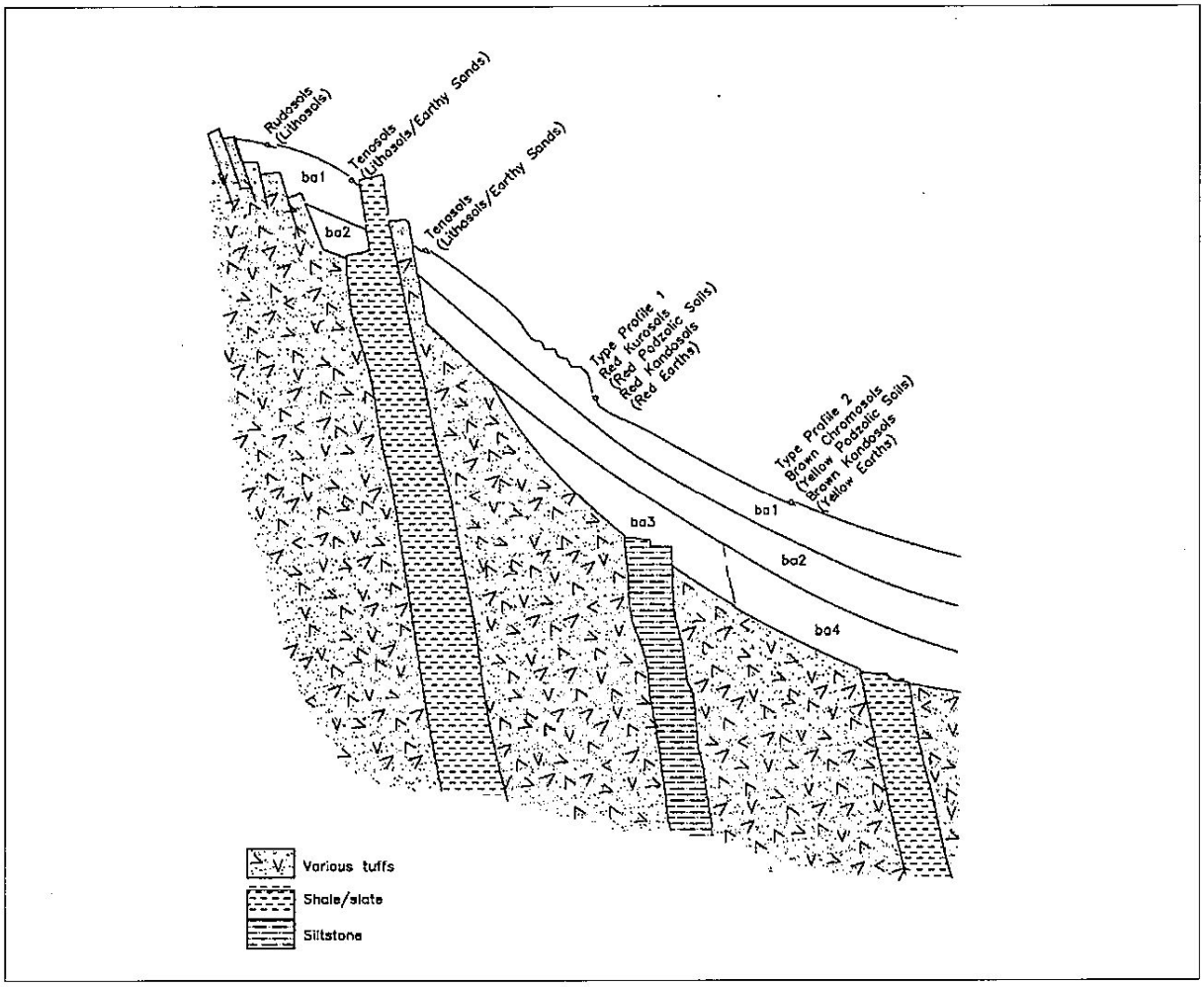


Figure G3 Distribution Diagram of Burra Soil Landscape Illustrating Occurrence and Relationship of Dominant Soil Materials (source: Jenkins, B.R. 2000)

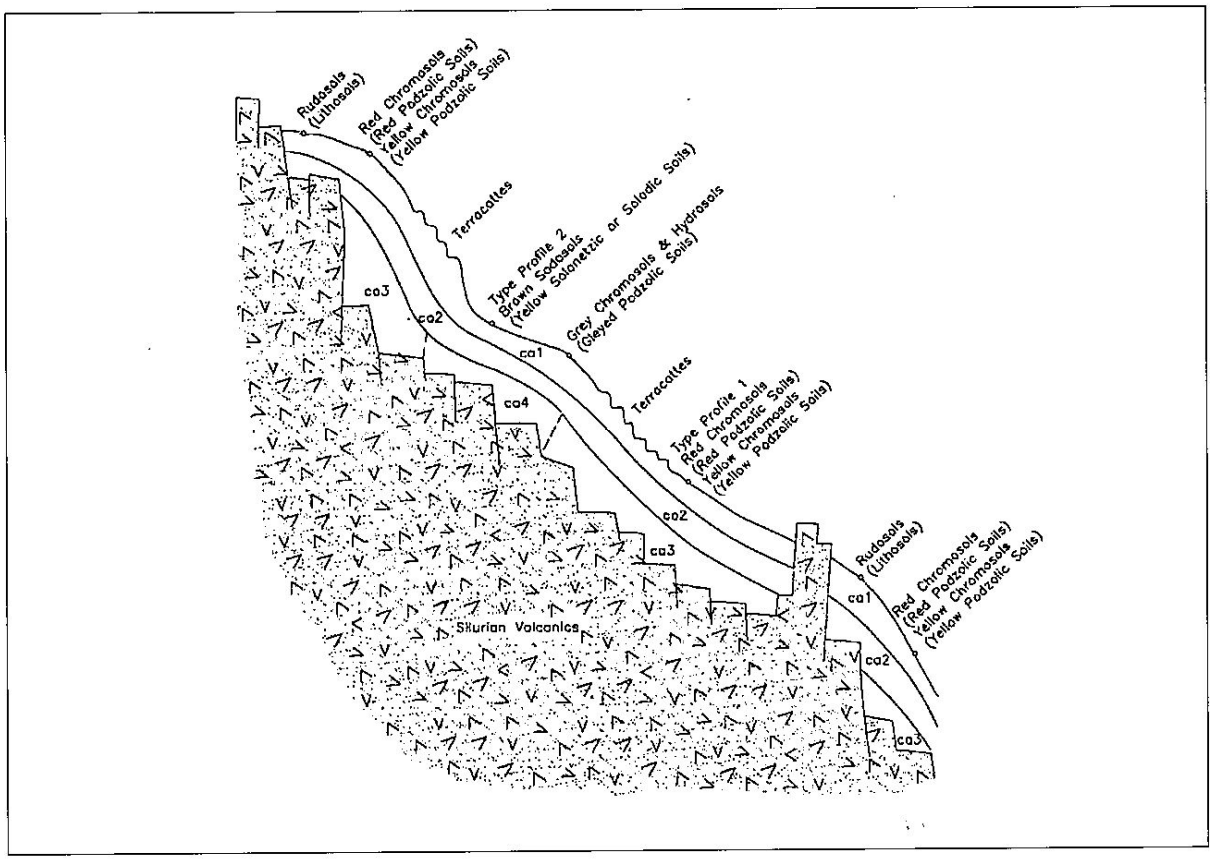
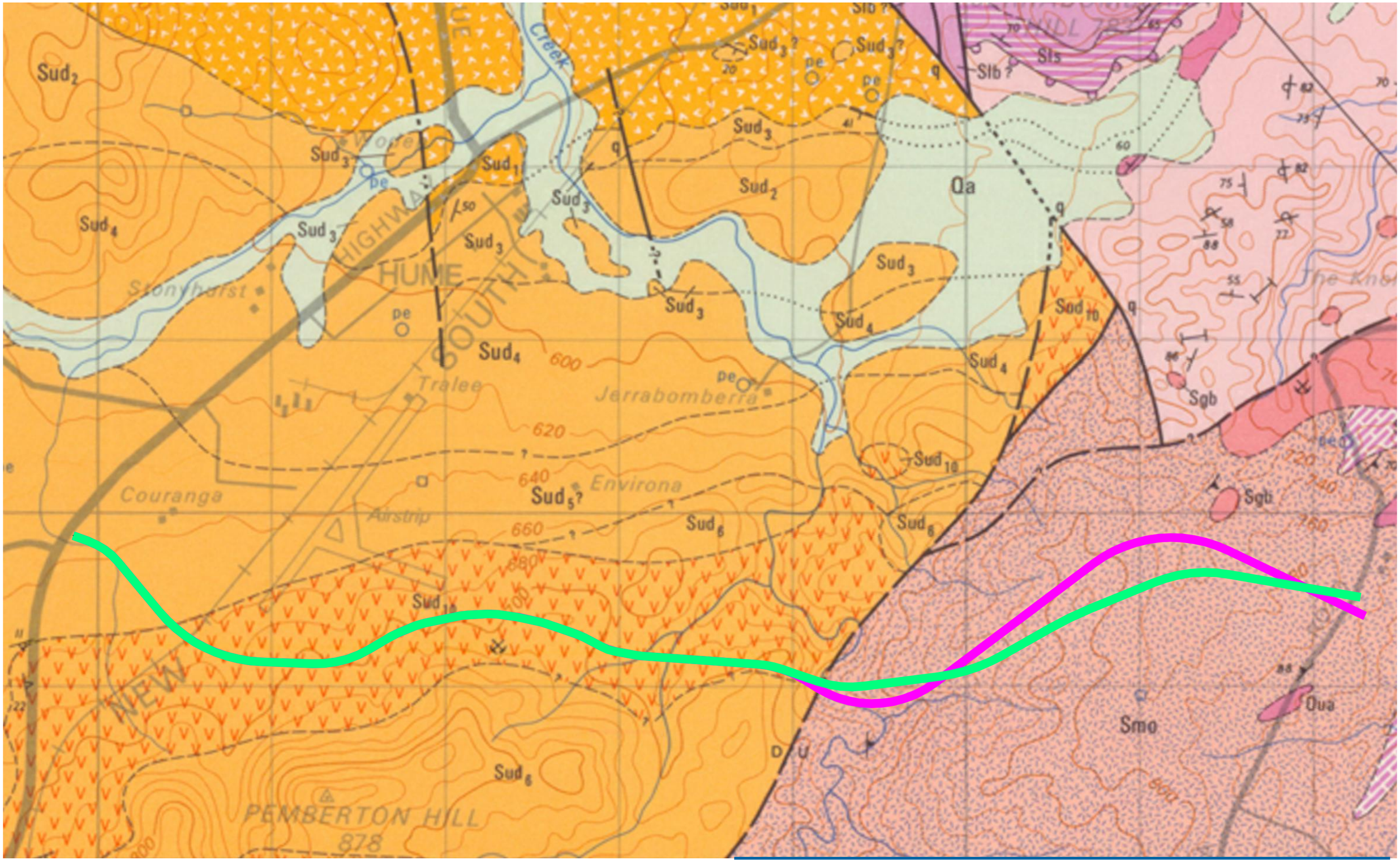


Figure G4 Distribution Diagram of Campbell Soil Landscape Illustrating Occurrence and Relationship of Dominant Soil Materials (source: Jenkins, B.R. 2000)



0 200 400 600m
SCALE 1:20,000 AT ORIGINAL SIZE

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rev no. | A

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

Figure E5

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

Plot Date: 07 December, 2007 - 9:34 AM Cad File No: G:\23\12266\CADD\Drawings\ 23-12266-FIG_E5.dwg



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