Alignment Options Report

Beaufort Bypass - Western Highway

Prepared for VicRoads (Client)

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Revision History

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on behalf of	Beca Consultants Pty Ltd		

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1 Introduction

The Western Highway Duplication Project is being developed by VicRoads to duplicate the highway between Ballarat and Stawell. As part of this overall objective, VicRoads have engaged Beca Consultants Pty Ltd (Beca) to develop alignment options for bypass routes around the town of Beaufort. The purpose of this report is to present the options developed for the town bypass and provide a preliminary assessment of their impacts against environmental, social, cultural, economic and engineering criteria.

1.1 Beaufort Bypass

The Western Highway is the primary road link between Melbourne and Adelaide and passes through the centre of the town of Beaufort. Road users utilising the current western highway travel through the urban environment with its corresponding speed restrictions, junctions and road user / pedestrian interactions. The primary purposes of the proposed bypass are to reduce travel time, increase freight efficiency and improve road safety.

1.2 The Project Study Area

The study area for the Beaufort Bypass – Western Highway is defined in the following manner:

- Around the town of Beaufort and providing a tie-in to the existing Western Highway to the east of Beaufort at a location west of Smith's Lane, and
- Around the town of Beaufort and providing a tie-in to the existing Western Highway to the west of Beaufort at a location east of Grampians view Road.

1.3 Purpose of this Report

Beca has been commissioned by VicRoads to develop alignment options for the bypass of the town of Beaufort. In accordance with the requirements of the Project Brief and current VicRoads practice, this report details the assessment of each the developed alignment options against the following categories and associated criteria:

- Environment / Ecology
- Community / Social
- Engineering
- Economics

This report will then form the basis, following endorsement by Vicroads and the Pyrenees Shire Council, for defining the preferred corridor within a planning context, thereby protecting it from future development and providing certainty for residents and prospective developers.

1.4 Report Structure

This report presents the various inputs, assessments and evaluations of the individual alignments as follows:

- Section 2 provides a descriptive summary of the individual alignment options considered as bypass routes for the town of Beaufort;
- Section 3 provides quantative details for each alignment in the form of an Assessment Balance Sheet which is then commented upon and evaluated in Sections 3.2 to 3.5, and
- Section 4 provides an assessment of the individual alignment options in the form of an Evaluation Matrix.

2 Description of Alignment Options

2.1 Alignments Forming Part of this Assessment

For details on the alignment options summarised below, refer to the scheme plans. All options are described from east to west.

The alignment options to the south of Beaufort are described below:

- Alignment Option B2-A – This option leaves the western highway, travels parallel to the Beaufort - Ballarat rail line before travelling south and across the western highway. It then runs to the west of the state forest to a point east of the Beaufort Reservoir. The total length of this option is 4.7km.
- Alignment Option B2-B – This option travels south from a point east of Beaufort Reservoir before turning westward to the south of the town, crossing the Beaufort – Ararat rail line and tying into the western highway at a point west of the Red Kangaroo Roadhouse. The total length of this option is 10.0km.
- Alignment Option B3-A – This option follows a similar path to that of Option B2-A but travels more westerly than that option before ending at a point east of the Beaufort Reservoir. The total length of this option is 4.4km.
- Alignment Option B3-B – This option travels south from a point east of Beaufort Reservoir before turning westward to the immediate south of the town, crossing the Beaufort – Ararat rail line and tying into the western highway at a point west of the Red Kangaroo Roadhouse. The total length of this option is 7.6km.

The alignment options to the north of Beaufort are described below:

- Alignment Option B4-A – This option leaves the western highway, travels parallel to the Beaufort - Ballarat rail line before travelling north and across the rail line. It then travels immediately east of the sewage treatment plant to a point north of the Beaufort Lexton Road. The total length of this option is 3.9km.
- Alignment Option B4-B – This option is a direct alternative to that of option B4-A. It leaves the western highway, travels parallel to the Beaufort - Ballarat rail line before travelling north and across the rail line at a point more easterly than that of B4-A. It then travels east of the sewage treatment plant to a point north of the Beaufort Lexton Road. The total length of this option is 3.7km.
- Alignment Option B4-C – This option travels from a point north of the Beaufort Lexton Road and continues to the north of the town before tying into the western highway at a point west of the Red Kangaroo Roadhouse. The total length of this option is 5.9km.

- Alignment Option B5-A – This option leaves the western highway, travels parallel to the Beaufort - Ballarat rail line before travelling north and across the rail line to a point immediately north of the rail line. The total length of this option is 1.75km.
- Alignment Option B5-B – This option travels from immediately north of the Beaufort - Ballarat rail line and continues to the north of the town, more northerly than that of option B4-C before tying into the western highway at the same location as B4-C. The total length of this option is 8.8km.

2.2 Alignments Consider But Not Forming Part of this Assessment

The following alignments were initially considered at the alignment development stage but were removed from the assessment process due to different factors:

- Alignment Option B1 – This option leaves the western highway to the east of Trawalla and travels south of the state forest, continuing south of the town centre before tying into the western highway east of Eurambeen Streatham Road. This alignment aimed to avoid the major constraints of the state forest and the planning zones to the south of the town but was deemed to be excessively long, resulting in higher construction costs and limited connectivity between passing traffic and Beaufort. The total length of this option is 20km.

- Alignment Option B6 – This option followed a similar path to that of Option B3-A and B3-B except that it tied into the western highway between the existing rail bridge crossing and the Old Shirley Road. This option was removed from further assessment as it contained many of the attributes applicable to Options B3-A and B3-B but greatly impacted the future short term growth of the town to the south west. The total length of this option is 7.3km.

- Alignment Option B7 – This option travelled through the centre of the town and utilised the existing western highway road reserve. The existing reserve went someway to accommodate the wider cross section of the Type M alignment however, the existing horizontal geometry was insufficient to accommodate the larger horizontal radii required of a freeway standard alignment. This option would have resulted in significant property acquisition and would have created significant community severance. The total length of this option is 5.8km

3 Assessment of Alignment Options

3.1 Assessment Balance Sheet

The following Table 1 details specific technical information for each alignment under the headings as defined in Section 1.3 of this report. Sections 3.2, 3.3, 3.4 and 3.5 provide a more detailed commentary of the various assessment criteria summarised in Table 1.

Table 1 – Beaufort Bypass – Western Highway Assessment Balance Sheet

			Route Alignment Options								
			Alignment Option B2-A	**Alignment Option B2-B**	**Alignment Option B3-A**	**Alignment Option B3-B**	**Alignment Option B4-A**	**Alignment Option B4-B**	**Alignment Option B4-C**	**Alignment Option B5-A**	**Alignment Option B5-B**
	Environment / Ecology										
Native Flora	Impact on known threatened species, populations or ecological communities		Minimal impact on vulnerable vegetation	Some impact on endangered and vulnerable vegetation	Some impact on endangered and vulnerable vegetation	Impact on endangered vegetation	Some impact on endangered vegetation	Some impact on endangered vegetation	impact on endangered vegetation	No impact on significant or protected vegetation	Significant impact on endangered vegetation
	Extent of native vegetation loss		1 ha vulnerable vegetation	3 ha endangered vegetation 6 ha vulnerable vegetation	2 ha endangered vegetation 2 ha vulnerable vegetation	15 ha endangered vegetation (EES trigger)	8 ha endangered vegetation	4 ha endangered vegetation	9 ha endangered vegetation		32 ha endangered vegetation (EES trigger)
Native Fauna	Impact on known threatened species, populations or ecological communities		Possible presence of Powerful Owl, Eastern Barred Bandicoot and Brush-tailed Phascogale across the study area	Possible presence of Powerful Owl, Eastern Barred Bandicoot and Brush-tailed Phascogale across the study area	Possible presence of Powerful Owl, Eastern Barred Bandicoot and Brush-tailed Phascogale across the study area	Possible presence of Powerful Owl, Eastern Barred Bandicoot and Brush-tailed Phascogale across the study area	Possible impact on Diamond Firetail Possible presence of Powerful Owl, Eastern Barred Bandicoot and Brush-tailed Phascogale across the study area	Possible impact on Diamond Firetail Possible presence of Powerful Owl, Eastern Barred Bandicoot and Brush-tailed Phascogale across the study area	Possible presence of Powerful Owl, Eastern Barred Bandicoot and Brush-tailed Phascogale across the study area	Possible impact on Diamond Firetail Possible presence of Powerful Owl, Eastern Barred Bandicoot and Brush-tailed Phascogale across the study area	Possible impact on Diamond Firetail Possible presence of Powerful Owl, Eastern Barred Bandicoot and Brush-tailed Phascogale across the study area
	Impact on known wildlife corridors		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wetlands	Impact on wetlands		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Community / Social										
Cultural Heritage	Impact on known cultural heritage sites		No identified sites of European cultural heritage Intersects with watercourses of Aboriginal cultural significance at 9 points	No identified sites of European cultural heritage Intersects with watercourses of Aboriginal cultural significance at 17 points	No identified sites of European cultural heritage Intersects with watercourses of Aboriginal cultural significance at 5 points	No identified sites of European cultural heritage Intersects with watercourses of Aboriginal cultural significance at 17 points	No identified sites of European cultural heritage Intersects with watercourses of Aboriginal cultural significance at 7 points	No identified sites of European cultural heritage Intersects with watercourses of Aboriginal cultural significance at 6 points	No identified sites of European cultural heritage Intersects with watercourses of Aboriginal cultural significance at 9 points	No identified sites of European cultural heritage Intersects with watercourses of Aboriginal cultural significance at 2 points	No identified sites of European cultural heritage Intersects with watercourses of Aboriginal cultural significance at 20 points
Property Severance	Displacement of residents & impact on land use	Land severance	1 property access severed	2 property accesses severed	1 property access severed	1 property access severed	1 property access severed	1 property access severed	1 property access severed	1 property access severed	2 property accesses severed
		Number of dwellings to be acquired	0	2 houses 3 sheds	0	0	1 shed	1 shed	1 house	0	1 house
		Area of land to be acquired	38.1ha	98.9ha	23.1ha	68.8ha	30.3ha	19.4ha	53.1ha	17.6ha	86.6ha
Social and Community Support	Community interaction, perceptions and attitudes		Intersects with land in a Public Conservation and Resource Zone	Conflicts with Council's preferred residential growth strategy	May impact on agricultural activity	Conflicts with Council's preferred residential growth strategy	Aligns with Council's preferred residential growth strategy and minimises impact on land parcels. Broadly aligns with Public Consultation Consensus	Intersects with land in a Public Conservation and Resource Zone	Aligns with Council's preferred residential growth strategy, but intersects with land in a Public Conservation and Resource Zone.	Minimal impact	Aligns with Council's preferred growth strategy, but may impact adversely on agricultural activity

		Route Alignment Options								
		Alignment Option B2-A	Alignment Option B2-B	Alignment Option B3-A	Alignment Option B3-B	Alignment Option B4-A	Alignment Option B4-B	Alignment Option B4-C	Alignment Option B5-A	Alignment Option B5-B
								Broadly aligns with Public Consultation consensus		
	Engineering									
Geotechnical	Difficult ground conditions	Excavations and cuttings through hills may intersect elevated terraces of unconsolidated sediments.	Excavations and cuttings through hills may intersect elevated terraces of unconsolidated sediments.	Excavations and cuttings through hills may intersect elevated terraces of unconsolidated sediments.	Excavations and cuttings through hills may intersect elevated terraces of unconsolidated sediments.	Excavations and cuttings through hills may intersect elevated terraces of unconsolidated sediments. Potential for lenses and larger deposits of soft soils as it travels through low lying flood plain deposits.	Excavations and cuttings through hills may intersect elevated terraces of unconsolidated sediments. Potential for lenses and larger deposits of soft soils as it travels through low lying flood plain deposits.	Excavations and cuttings through hills may intersect elevated terraces of unconsolidated sediments. Potential for lenses and larger deposits of soft soils as it travels through low lying flood plain deposits. (minimal instances)	Excavations and cuttings through hills may intersect elevated terraces of unconsolidated sediments.	Excavations and cuttings through hills may intersect elevated terraces of unconsolidated sediments. Potential for lenses and larger deposits of soft soils as it travels through low lying flood plain deposits.
	Contaminated land	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Hydrology	Waterways and flood plains	9 crossings of waterways; 0 crossings of flood / retention area	17 crossings of waterways; 0 crossings of flood / retention area	5 crossings of waterways; 0 crossings of flood / retention area	17 crossings of waterways; 0 crossings of flood / retention area	7 crossings of waterways; 1 crossing of flood / retention area	6 crossings of waterways; 1 crossing of flood / retention area	9 crossings of waterways; 1 crossing of flood / retention area	2 crossings of waterways; 0 crossings of flood / retention area	20 crossings of waterways; 1 crossing of flood / retention area
Utility Services	Impact on utility services	1 electrical crossing, 1 fibre optic crossing	1 fibre optic crossing	1 electrical crossing	2 electrical crossings, 1 fibre optic crossing	1 electrical crossing, 1 fibre optic crossing	1 electrical crossing, 1 fibre optic crossing	1 fibre optic crossing	1 electrical crossing, 1 fibre optic crossing	1 fibre optic crossing
Railway	Impact on railway	0	1 new bridge crossing	0	1 new bridge crossing	1 new bridge crossing	1 new bridge crossing	0	1 new bridge crossing	0
Safety	Extent of hazards	Alignment B2 (A+B) increases western highway route by almost 40% therefore increasing accident possibilities.	Alignment B2 (A+B) increases western highway route by almost 40% therefore increasing accident possibilities.	Alignment B3 (A+B) increases western highway route by almost 25% therefore increasing accident possibilities.	Alignment B3 (A+B) increases western highway route by almost 25% therefore increasing accident possibilities.	Alignment B4 (A+B+C) caters for logging traffic to/from the north of the town removing such traffic from town centre. Shorter of route options therefore reducing accident possibilities	Alignment B4 (A+B+C) caters for logging traffic to/from the north of the town removing such traffic from town centre. Shorter of route options therefore reducing accident possibilities	Alignment provides a natural fire break between the wooded areas to the north and Beaufort. Long, almost straight, alignment. Alignment B4 (A+B+C) caters for logging traffic to/from the north of the town removing such traffic from town centre.	Alignment B5 (A+B) caters for logging traffic to/from the north of the town removing such traffic from town centre.	Alignment B5 (A+B) caters for logging traffic to/from the north of the town removing such traffic from town centre.
	Economics									
Cost	Travel efficiency	4.7km long. 0 roads severed	10km long. 0 roads severed	4.4km long. 0 roads severed	7.6km long. 1 roads severed	3.9km long. 0 roads severed	3.7km long. 0 roads severed	5.9km long, 1 roads severed	1.75km long, 0 roads severed	8.8km long, 0 roads severed

		Route Alignment Options								
		Alignment Option B2-A	Alignment Option B2-B	Alignment Option B3-A	Alignment Option B3-B	Alignment Option B4-A	Alignment Option B4-B	Alignment Option B4-C	Alignment Option B5-A	Alignment Option B5-B
	Construction cost ($ million)	$47	$132	$46	$90	$59	$74	$64	$29	$107
	Land Acquisition cost ($ million)	$0.35	$1.25	$0.20	$0.95	$0.25	$0.125	$0.35	$0.125	$0.60

3.2 Environmental / Ecological Criteria

This section details the key findings from the assessment of environmental / ecological criteria associated with the proposed Beaufort bypass alignment options. Native flora and fauna data from State and Federal records has been plotted to inform this assessment of environmental / ecological criteria.

No contaminated sites were identified as being impacted by the proposed Alignment Options. However future detailed on-site technical investigation is required to confirm the mapping data.

3.2.1 Native Flora

The assessment of native flora criteria has been informed by the Desktop Flora and Fauna Assessment of the Western Highway, Burrumbeet to Stawell, Victoria prepared by Ecology Partners in July 2008 in addition to the Bioregional Conservation Status of Ecological Vegetation Classes (EVCs)1 and areas protected by Environmental Overlays.

The EVCs occurring within the study area are Grassy Woodland/Heathy Dry Forest Complex Plains Grassy Woodland, Alluvial Terraces Herb-rich Woodland, Creekline Grassy Woodland, Heathy Woodland and Valley Grassy Woodland. This mapping shows that the Beaufort Township and immediate surrounds support a significant amount of endangered vegetation. Refer to drawing entitled 'Alignment with Ecological Vegetation Classes'. The EVCs range in Bioregional Conservation Status from vulnerable to endangered.

These corridors extend to the north, west, south and north east and are intersected by all proposed alignment options.

The following table shows an approximate measure of vegetation lost against each alignment and section.

Table 2 – Vegetation Impact per Alignment Option

Alignment	Option	Endangered* (ha)	Vulnerable* (ha)	Depleted* (ha)	Option Total (ha)
B2	A	0.0	0.8	0.0	0.8
	B	3.2	6.4	0.0	9.6
B3	A	1.6	1.6	0.0	3.2
	B	15.2	0.0	0.0	15.2
B4	A	8.0	0.0	0.0	8.0
	B	4.0	0.0	0.0	4.0
	C	8.8	0.0	0.0	8.8
B5	A	0.0	0.0	0.0	0.0
	B	32.4	0.0	0.0	32.4

* Where EVC areas track along road and river corridors, this assessment assumes 200m at river intersections and 100m at road intersections

[1] EVCs are a hierarchical system used to classify plant communities. EVC's are defined by a combination of floristic, life form, position in the landscape and an inferred fidelity to a particular environment. Each EVC includes a collection of floristic communities (i.e. groups based on co-occurring plant species) that occur across a biogeographic range and although differing in species, have similar habitat and ecological processes operating.

Analysis of the mapped data indicates the following native flora impacts:

- All Alignment Options intersect with areas of endangered vegetation and the southern Alignment Options B2-B and B3-A also intersect with areas of vulnerable vegetation;
- Alignment Option B5-B has the greatest impact on endangered vegetation, requiring the removal of approximately 32 hectares to the north of the township while Alignment Option B3-B would require the removal of approximately 15 hectares of endangered vegetation to the south of the Beaufort Township.
- The least amount of endangered vegetation would be lost to facilitate Alignment Option B2-A compared with other Alignment Options;
- Alignment Option B3-B and B5-B require the removal of ten hectares or more of vegetation with an EVC category of endangered and thereby trigger the preparation of a full scale Environment Effect Statement under the Environment Effects Act 1978.

Furthermore it is noted that all Alignment Options intersect with land covered by an Environmental Significance Overlay in the Pyrenees Planning Scheme. This applies to significant vegetation areas and environmentally sensitive areas such as waterway corridors.

Alignment Option B2-A, B4-B and B4-C also traverse through areas covered by a Public Conservation and Resource Zone which aims to protect and conserve the natural environment and triggers the requirements for detailed technical studies and higher level stakeholder engagement.

It is highlighted that the above analysis calculates the total area of land which supports endangered or vulnerable EVCs, which is affected by the proposed alignment option. This therefore assumes that all of the land included in the estimate supports quality native vegetation which will be lost as a result of the road construction.

A further detailed flora survey and a habitat hectare analysis is necessary to determine the exact extent of native vegetation loss resultant from the proposed Alignment Option for the Western Highway Beaufort Bypass.

3.2.2 Native Fauna

The DSE's EVC mapping identifies a number of threatened and endangered species in the study area. These are listed in the table below.

Table 3 – Impact on Threatened or Endangered Species

Locations	Species	Alignment Impacts
Beaufort township and west	Eastern Barred Bandicoot	All
Entire study area	Brush-tailed Phascogale	All
North east of Beaufort township	Diamond Firetail	B4- A, B4-B B5 – A, B5-B, B5-C
Entire study area	Possible presence of Powerful Owl	All

Analysis of the mapped data indicates the following native fauna impacts:

- All Alignment Options pass through areas which impact on the habitat of threatened or endangered native fauna.

According to the Desktop Flora and Fauna Assessment of the Western Highway, Burrumbeet to Stawell, Victoria remnant Woodland provides habitat and facilitates the movement of fauna species

throughout an area dominated by cleared farmland, and therefore constitutes a wildlife corridor. The Ecology Partners report (July 2008) notes that remnant Woodland vegetation is present in scattered patches along the length of the Western Highway between Stawell and Burrumbeet.

Further detailed fauna surveying is necessary to determine the extent of impact to native fauna and habitat corridors resultant from the proposed Alignment Options for the Beaufort Bypass.

3.2.3 Wetlands

The Beaufort reservoir is located to the south of the township settlement. It is not impacted by any of the proposed alignment options.

No other wetland areas are located within the study area.

3.3 Community / Social Criteria

3.3.1 Cultural Heritage

An assessment of cultural heritage criteria has also been informed by a review of the *Cultural Heritage Desktop Study* for the Western Highway Duplication between Burrumbeet and Stawall prepared by Dr Vincent Clark and Associates in October 2008. The following data has been considered during the assessment of cultural heritage values associated with the Beaufort bypass:

- Previously Recorded Aboriginal Sites including:
  - Scarred Tree;
  - Artefact Scatter;
  - Ceremonial Place;
- Areas protected by the Heritage Overlay; and
- Areas of Aboriginal Cultural Heritage Sensitivity.

A Heritage Overlay affects the entire town centre of Beaufort. This identifies the area and a number of component elements as having European cultural heritage significance including architectural significance and triggers the requirement for additional technical support for any works affecting this area. A number of individual sites in the study area are also covered by the heritage overlay and identified as having cultural or architectural significance. These sites are shown on the drawing entitled 'Alignments with Environmental & Planning Overlay Constraints'.

These sites are not directly impacted by any alignment options presented.

Areas of cultural heritage sensitivity, as defined by Aboriginal Affairs Victoria (AAV), are areas within 200m of named watercourses and within 50m of recorded Aboriginal archaeological sites. As identified in Table 1, all alignment options incorporate multiple waterway crossings. These watercourses may be areas of AVV sensitivity, and based on the frequency of previously recorded archaeological and heritage sites, a Cultural Heritage Management Plan (CHMP) will need to be prepared prior to any high impact activities[2] under Division 3 of the *Aboriginal Heritage Regulations* 2007 (which accompany the *Aboriginal Heritage Act* 2006).

[2] A high impact activity is an activity that may have a high impact on Aboriginal cultural heritage. Examples of high impact activities under the Regulations include certain construction or building works; an activity for which an earth resource authorisation is required; certain timber production; and subdivisions into three or more lots if a dwelling may be constructed on each of the lots.

Analysis of the mapped data indicates the following impacts to cultural heritage:

- All Alignment Options incorporate waterway crossings and will therefore trigger the requirement for further investigation and the preparation of a CHMP;
- Alignment Option B5-B incorporates 20 waterway crossings., and
- No Alignment Option interfere with any specific previously identified sites of European or Aboriginal cultural heritage

3.3.2 Land Severance

The assessment of land severance was informed by land ownership cadastral data obtained from VicRoads. Properties were assessed based on access severance as well as dwellings and other structures to be acquired. Where existing access is severed, alternate access will have to be provided. Options for alternate access include new access roads and upgrade of alternate routes. Total amount of land acquisition required for each option was also a criterion.

3.3.3 Community Interaction, Perceptions and Attitudes

A review of Council's strategic planning was undertaken to identify any possible future social and community impacts of the proposed bypass. This review identified that the preferred direction for future residential growth in the Beaufort Township is south of the existing town centre. This is due to land availability in this area and the natural topographic barrier to development created by the hills directly to the north of the township. The southern residential expansion has statutory support from the land use zoning in the Pyrenees Planning Scheme and Council.

The southern Alignment Options B2-A, B2-B and B3-A and B3-B, are likely to define the southern limit of this residential expansion.

Discussions with Council indicate support for northern alignment options with a view to preserving land to facilitate expansion to the south of the township to support a growing residential population.

The land surrounding the Beaufort Township is identified as Farm Zone in the Pyrenees Planning Scheme and as such further detailed investigation of the impact on operational agricultural land must also be undertaken.

The impact and compatibility of alignment options on surrounding uses with respect to noise, light, drainage, run-off and emissions must also be considered in their development and assessment. Further consultation with local community and stakeholders is required to investigate these impacts and to satisfy the social and environmental requirements of the Transport Integration Act 2010. This could be undertaken in the form of a Social Impact Assessment.

3.4 Engineering Criteria

This section details the key findings from the assessment of engineering criteria associated with the Beaufort Bypass - Western Highway alignment options.

3.4.1 Geotechnical

The Geotechnical Desktop Study identifies 5 zones which are inferred to have different geotechnical properties. These zones have been ranked in order of favourability for road construction. A rank of 1 is most favourable; a rank of 8 is least favourable. The rankings are as follows:

- GD01 - Rank of 1
- GD04 - Rank of 2
- GD02 - Rank of 3
- GD03 - Rank of 4
- GD05 - Rank of 5

In terms of the above ranking, Alignment Options B2 (A & B), B3 (A & B) and B5-A are the most favourable alignments with Alignment Option B5-B being the least favourable given its lengthier distance through poor ground conditions.

The complete Geotechnical Desktop Study is presented in Appendix A.

3.4.2 Hydrology

No hydrological study was performed as part of this assessment. The assessment of hydrology is informed by data obtained from the Department of Sustainability and Environment. Alignment Options B4-A, B4-B and B5-B impact on existing areas of flooding / inundation as evidenced in recent flooding. These areas are significant in nature and have historically increased in size due to recent flood events.

The number of stream crossings was also a criterion of the hydrologic assessment.

Refer to Drawing “Alignments with Environmental & Planning Overlay Constraints’ for details of all hydrological features within the study area.

3.4.3 Utility Services

Existing utility data was requested from Dial Before You Dig. Responses were received from:

- Optus – plans indicate that services are extensive throughout the project study area. Fibre optic cable runs along the existing rail line from the east and through the town centre before running along Back Raglan Road and onto the western highway towards Ararat.
- Telstra – plans indicate that services are extensive throughout the urban study area and run along all approach routes to the town.
- Powercor Australia – plans indicate that electrical services are extensive throughout the urban study area.

3.4.4 Railway

The assessment of railway impact primarily focuses on the number of new rail crossings proposed.

All Alignment Options to the north of Beaufort impact the existing east-west rail line which accommodates passenger transport between Beaufort and Ballarat and beyond. Similarly, all

Alignment Options to the south of Beaufort impact the existing east-west rail line which accommodates passenger transport between Beaufort and Ararat and beyond.

While some alignment options follow the existing rail alignment, sufficient clearance or safety barrier between the proposed carriageway and the rail would be ensured during design.

3.4.5 Safety

Alignment Options B5 (A+B combined) and B4 (A+B+C combined) cater for traffic traveling to/from the north of the town and therefore reducing the quantity of large vehicles through the town centre. This would have a positive impact on pedestrian and road user's safety in the town centre itself.

Alignment Options B4-C and B5-B provide a natural fire break between the town and the forested areas to the north. However Option B4-C contains a generally straight alignment over a long distance therefore possibly increasing the effects of fatigue.

Alignment Option B2 (A+B combined) results in 40% (approx.) increase in journey distance due to its remote position from the western highway thereby increasing the accident risk to road users over that of shorter alignments.

3.5 Economics Criteria

This section details the key findings from the assessment of economic criteria associated with the Western Highway Duplication – Armstrong to Stawell alignment options.

3.5.1 Land Acquisition

A summary of the estimated cost of land acquisition for each alignment is presented below in Table 2. Details are provided in Appendix C.

Table 4 – Land Acquisition Estimate

Option	Estimated Area to be Acquired	Estimated Cost (to nearest $25,000)
Option B2-A	38.1ha	$350,000
Option B2-B	98.9ha	$1,250,000
Option B3-A	23.1ha	$200,000
Option B3-B	62.8ha	$950,000
Option B4-A	30.1ha	$225,000
Option B4-B	19.4ha	$125,000
Option B4-C	53.1ha	$325,000
Option B5-A	17.6ha	$125,000
Option B5-B	86.6ha	$600,000

This estimate is based on an assumed 80m typical corridor for each alignment. Provisions for interchanges and access roads have also been made in the proposed corridors. The following rates have been developed following consultation with VRC Property on behalf of Pyrenees Shire Council and have been applied to develop this estimate:

- PCRZ Public Conservation & Resource Zone $3,750 per hectare
- RCZ Rural Conservation Zone $5,000 per hectare
- RLZ Rural Living Zone $15,000 per hectare

- FZ Farming Zone $7,500 per hectare

Further details are provided in Appendix C.

3.5.2 Construction Cost

A summary of the estimated cost of construction for each alignment is presented below in Table 3. Details are provided in Appendix B.

Table 5 – Construction Cost Estimate

Option	Estimated Construction Cost (to nearest $1million)
Option B2-A	$47m
Option B2-B	$132m
Option B3-A	$46m
Option B3-B	$90m
Option B4-A	$59m
Option B4-B	$74m
Option B4-C	$64m
Option B5-A	$29m
Option B5-B	$107m

Table 6 – Construction Cost Estimate (per Overall Route)

Option	Estimated Construction Cost
Route B2	$179m
Route B3	$136m
Route B4	$197m
Route B5	$136m

4 Evaluation of Options

4.1 Evaluation Matrix

The following Evaluation Matrix was prepared by Beca Consultants Pty Ltd.

The Matrix is coded as follows:

Meets criteria very well	
Meets criteria well	
Meets criteria moderately well	
Meets criteria poorly	
Meets criteria very poorly	

Table 4 – Evaluation Matrix

ENVIRONMENT / ECOLOGICAL		Route Alignment Option								
CATEGORY	**DESCRIPTION OF CRITERIA**	**Alignment Option B2-A**	**Alignment Option B2-B**	**Alignment Option B3-A**	**Alignment Option B3-B**	**Alignment Option B4-A**	**Alignment Option B4-B**	**Alignment Option B4-C**	**Alignment Option B5-A**	**Alignment Option B5-B**
ENVIRONEMANTAL / ECOLOGY										
NATIVE FLORA	Impact on known threatened species, populations or ecological communities									
	Extent of native vegetation loss									
NATIVE FAUNA	Impact on known threatened species, populations or ecological communities									
	Impact on wildlife corridors	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WETLANDS	Impact on wetlands	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
COMMUNITY / SOCIAL										
CULTURAL HERITAGE	Impact on known cultural heritage sites									
PROPERTY SEVERANCE	Land severance									
	Number of dwellings likely to be acquired									
	Estimated area of land to be acquired (hectares)									
SOCIAL IMPACT AND COMMUNITY SUPPORT	Community interaction, perceptions and attitudes									
ENGINEERING										
GEOTECHNICAL	Avoid difficult ground conditions									
	Contaminated land									
HYDROLOGY	Waterways and flood plains									
UTILITY SERVICES	Impact on utility services									
RAILWAY	Impact on railway									
SAFETY	Extent of hazards (AMP1)									
	Extent of hazards (AMP3)									
ECONOMICS										
COST	Travel efficiency									
	Estimated project cost ($ million)	**$47.35**	**$132.25**	**$46.2**	**$90.95**	**$59.25**	**$74.125**	**$64.35**	**$29.125**	**$107.6**

5 APPENDICES

Appendix A

Desktop Geotechnical Study

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Beaufort Bypass Geotechnical Desk Study

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May 2011





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Beaufort Bypass Geotechnical Desktop Study

Contents Amendment Record

This document has been issued and amended as follows:

Issue 1					
Rev	**Description**	**Date**	**Prepared by**	**Checked by**	**Authorised by**
01	Beaufort Bypass Geotechnical Desktop Study DRAFT	09.05.11	J. Harendran	A. Doe	P. Styles
02	Beaufort Bypass Geotechnical Desktop Study DRAFT	13.05.11	J. Harendran	A. Doe	P. Styles
03	Final Issued Document	14.06.11	J. Harendran	A. Doe	P. Styles

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1 INTRODUCTION

Halcrow has been commissioned by Beca Pty Ltd (Beca) to conduct a geotechnical desktop study regarding the proposed Beaufort Bypass. This study supports the CORRIDORS STUDY – BEAUFORT BYPASS, WESTERN HIGHWAY conducted by Beca for VicRoads.

The purpose of this study is to collate available geotechnical and geological data relevant to the proposed bypass options and report on the following key points:

- Where geological features are likely to impose significant additional costs;
- Where geological features are likely to impose significant restrictions to the time of construction;
- Anticipated geology beneath the study area.

2 AVAILABLE DATA

Relevant data was sourced from various sources including the following:

- The Department of Primary Industries Victoria,
- VicRoads, online and special contacts sourced by Phil Styles
- General news and community sources.

A detailed list of references is provided at the end of this report.

3 ANTICIPATED GROUND CONDITIONS

3.1 Geological History

The following summary of the geological history of Beaufort is extracted and modified from Cayley (1995).

1. Cambrian and Late Devonian

- Submarine volcanism (not exposed in Beaufort) in the Cambrian to Late Devonian, followed by;
- Deposition of marine sediments in the Ordovician to Middle Devonian, this includes the siltstones and sandstones of the St Arnaud Group that were formed by turbidite flows, which underlie most of the area of interest for the Beaufort bypass, followed by;
- Episodes of regional metamorphism, folding, faulting, intrusion of granite masses, contact metamorphism and mineralisation

2. Late Devonian to Mid-Mesozoic

- A period of tectonic stability and erosion
- Erosion resulting in a landscape of low to gentle relief by the middle of the Mesozoic

3. Mid Mesozoic to present

- The break up of the Gondwana super-continent, followed by;
- Opening of the Tasman Sea and subsidence of the Otway basin to below or just above sea level, which lies South of Beaufort, followed by;
- Uplift of the area inland of the Otway basin, including Beaufort, followed by
- Episodes of erosion separated by periods where changing sea levels caused widespread non-marine deposition in the Tertiary, followed by;

- An episode of non-marine basaltic volcanism in the later tertiary to Pliocene. This includes the volcanic deposits that lie to the east of Beaufort. These lava flows temporarily or permanently blocked streams in the Beaufort area resulting in significant changes in depositional patterns of sediments.

3.2 Expected Subsurface Conditions

Figure 1 includes an extract from the local 1:100,000 scale geological map (Cayley and McDonald 1995), which has been geo-referenced and overlain by the initial alignment options provided by Beca.

The area of interest for the Beaufort bypass has been categorised based on the expected underlying geology and surface geomorphology. These zones titled "Geological Domains" are listed and described in Table 3-1 below, and graphically defined in Figure 2.

Table 3-1: Summary of Expected Geology and Geomorphology

Geological Domain	Underlying Geology and Geomorphology	Geotechnical Risks & Construction Related Considerations	Additional Comments / Land Use
GD01	The White Hills Gravel, fluvial gravel, course quartz gravel to cobble sized in a matrix of sand, silt and clay, occasional boulders of quartz. The lower slopes of hills are flanked by colluvium, deposits from erosion of the slope comprising poorly consolidated gravel, sand and silt.	• Cuttings through unconsolidated gravels will require appropriate slope design.	Greenfields land comprising mainly farms and forests. The White Hills Gravel is a significant source of gravel that has been used for road base course material. However clay content can have a high plasticity index, possibility rendering the gravels unsuitable for use a road base.
GD02	Red basaltic soil underlain by basalt (volcanic lava deposit) at depth. The basalt tends to have a deep weathering profile.	• Basaltic soils tend to have a high shrink-swell potential and high plasticity index. • Layers of stronger basalt may be present at any depth due to variability of lava flows/weathering	Greenfields land comprising mainly farms and forests.
GD03	Flood plains and very low hills comprised of colluvium and alluvium. Existing stream deposits of unconsolidated gravel, sand and clay. Older stream deposits of well graded sandy clay, occasional sand lenses and gravel beds. Gullies and the boundaries of hills covered in slope wash and fans of eroded material comprising well graded, unconsolidated gravel, sand and silt. The underlying bedrock is marine turbiditic sandstone, mudstone and siltstone of the Pyrenees Formation and the Beaufort Formation.	• Potential for lenses and larger deposits of soft soils in river channels and flood plains. • Existing creeks and low points will require bridges or appropriate culverts. • There is increased risk of flooding where roads are constructed in low lying areas.	Greenfields land comprising mainly farms and forests.
GD04	Low lying hills comprised of marine turbiditic sandstone, mudstone and siltstone of the Pyrenees Formation and the Beaufort Formation (the St Arnaud Group of Ordovician to Cambrian age). Creeks and gullys at the base of these hills are filled with either recent alluvium or colluvium comprised of unconsolidated well graded sand, clay and sand. Some hills, particularly those within 4Km of the Beaufort town centre, contain elevated terraces of unconsolidated older alluvial sediments of well graded sand, gravel and clay.	• Excavations and cuttings through hills may intersect elevated terraces of unconsolidated sediments. • There are several minor creeks that may require bridges or culverts. • The southernmost initial alignment option traverses through several farm dams and houses. • Small scale slips may affect stability of cuttings and embankments	Greenfields land comprising mainly farms and forests.
GD05	Basalt bedrock at depth and basaltic soil flanking areas of swamps and lacustrine swamp deposits. Swamp deposits are comprised of dark brown mud and clay, minor fine grained sand; rich in organic matter, minor peat deposits.	• Basaltic soils tend to have a high shrink-swell potential and high plasticity index. • Swamp related sedimentary deposits may be highly compressible and problematic. Road construction in this area may require significant ground improvement.	Greenfields land comprising mainly farms and forests.

3.3 Bridges

Some historical design drawings have been provided by VicRoads regarding two bridges in the Beaufort area, on the Western Highway (VicRoads 1962 & VicRoads 1966). The following key points are derived from these drawings, however they must be considered in the context of the VicRoads "Conditions for the Provision of Geotechnical Data", which states that the documents are provided for information purposes only, and that no guarantee is granted regarding the accuracy or completeness of the data. The lithological terminology and logging used in these historical documents may not be accurate. The points are as follows:

Bridge over the railway line on the Western Highway, 2Km West of Beaufort Township:

- The bridge is comprised of two abutments and two central piers.
- The road level sits on approximately 6m depth of fill.
- The abutments are founded in "soft mudstone".
- The natural geology of the site is comprised of approximately 0.6m of clay, underlain by "soft mudstone".

Bridge over Fiery Creek on the Western Highway, Central-Eastern Beaufort Township:

- The bridge is comprised of two abutments and two central piers, all founded on piles that extend to approximately 12m depth from the road surface.
- The road level sits on approximately 2.4m depth of fill.
- The piles terminate in or just above "Basalt" at a depth of approximately 8m below the natural surface. The soils above the "basalt" are reported to be silt, silty clay, sandy clay and clay.
- Note that according to the geological map (Cayley R.A. 1995), the geology of this area is comprised of alluvium and colluvium (GD03). This data suggests that basalt underlies these sediments in this area.

These bridges may have been upgraded or changed since the time of this design drawing.

3.4 Problematic Soils

The available information for the Beaufort area does not provide specific data regarding the thickness of compressible clays, silts and swamp deposits. However deposits in GD03 have potential to contain lenses or significantly thicker layers of compressible soils. GD04 includes swamp deposits underlain by basalt. Issues related to construction on soft soil can be mitigated by avoiding swampy areas where possible as well as drilling and site investigation in order to detect problematic soils early in the design.

3.5 Slope Stability & Embankment Stability

The geological map of Beaufort (Cayley and McDonald 1995) has provision to include landslide deposits (denoted by Qx). However Cayley (1995) has noted that relief of Beaufort is too gentle for large scale landslides. He goes on to state, "*Many small rotational slips occur on the steep slopes in the Pyrenees Range, especially those which have been cleared, resulting in destabilisation of the soil and rocks. These slips are too small to be denoted on the map (1:10000), but they do form a significant land use problem. Many of these slips are active only in the winter months when the soil is saturated.*"

The small slips mentioned by Cayley (1995) may also occur on the proposed initial alignment options in the area denoted by GD04 in Figure 2. The hills in this area are relatively low lying but are likely to require cuttings in order to achieve a practical design grade for the proposed bypass.

Figure 3-1 Photograph of a railway cutting near Beaufort (Bonzle 2011)

3.6 Surface Water

The township of Beaufort and surrounding land was significantly affected by the floods of January 2011. News reports indicate that parts of the town and the railway line were inundated. The township is itself built in a low lying area flanked by streams to the north-east. A significant low lying area is to the west of the town, denoted by Geological Domain 03 (GD03) in Figure 2, this area is underlain by alluvial sediments and has surface water in streams and mudflats. It is anticipated that GD03 and GD04 will be susceptible to flooding during significant flood events.

3.7 Mines – Existing and Historic

A search of the online databases of selected government departments was conducted. Beaufort is in an area that was mined extensively during the period of the Victorian gold rush. Most of these workings were surface alluvial excavations but there remains the potential for small underground excavations.

According to the Department of Primary Industries (DPI) register of current exploration licenses (DPI 2011a), exploration license EL4935 covers the area of

interest for the Beaufort Bypass. EL4935 is owned by Oroya Mining Ltd, Suite 3, 72 Canning Hwy, Perth WA 6100. Oroya Mining are particularly interested in the Fiery Creek lead, which is situated to the north east of Beaufort township (DME-Vic 1984).

According to the DPI GeoVic database (DPI 2011b), there have been several mineral exploration licenses that are now expired, that cover the area of interest for the Beaufort Bypass. Figure 3 is an extract from the GeoVic database (DPI 2011b) which shows historical mines and mineral occurrences in the vicinity of Beaufort township.

It should be noted that mapping of historical mines and mineral occurrences may not be exhaustive.

4 REFERENCES

Cayley R.A. & McDonald P.A. (1995) Beaufort 1:100 000 Map Geological Report, Geological Survey of Victoria Report 104

Cayley R.A. (1995) Beaufort 1: 100 000 Geological Map, Geological Survey of Victoria

Australian Mining Atlas (2011) http://www.australianminesatlas.gov.au/ , cited 29/4/2011

Department of Primary Industries (2011a) http://new.dpi.vic.gov.au/earth-resources/industries/minerals/current-licences--and--permits, cited 29/4/2011

Department of Primary Industries (2011b) http://new.dpi.vic.gov.au/earth-resources/products-services/online/geovic, cited 29/4/2011

Google (2011) Google Earth Professional software, satellite images cited April 2011.

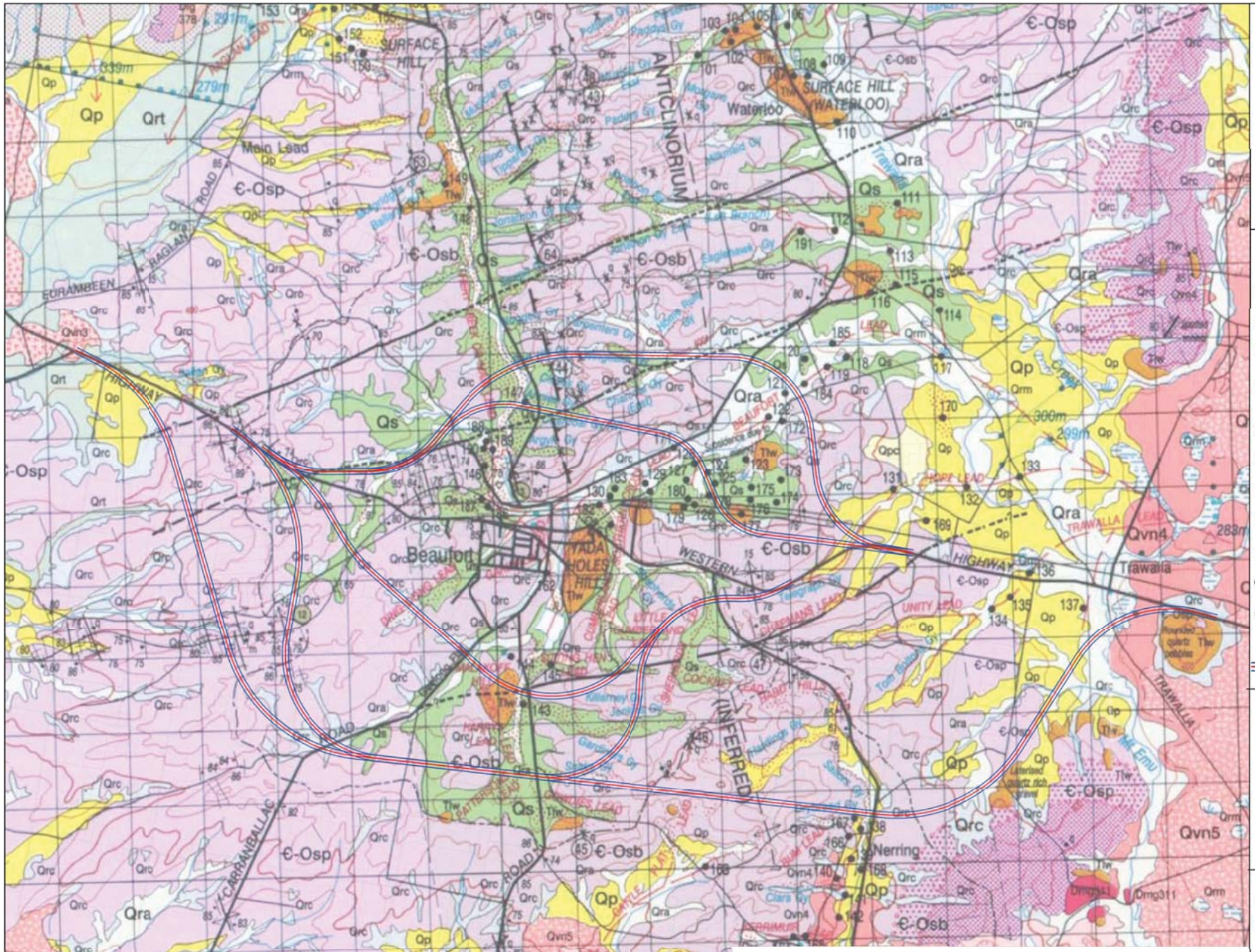
Bonzle.com (2011) http://maps.bonzle.com/c/a?a=pic&fn=5bfbgvsp&s=4, Image of railway cutting near Beaufort, cited 29/4/2011

DME-Vic (1984) Deep Lead Gold Deposits in Victoria Map No. 3 Beaufort, Bulletin No. 62, Department of Minerals and Energy Victoria

VicRoads (1962) Design Drawing for the Bridge over Fiery Creek – Central Beaufort Township, Country Roads Board, Project 6369m Contract No. 528 N2 280, Drawing 40759

VicRoads (1964) Design Drawing for the Bridge over Railway Line (Approx 2Km West of Beaufort), Country Roads Board, Project 6837, Contract 522 LC2 565, Drawing 41752, Sheets 1 & 2 of 9

Figures



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SIMPLIFIED LEGEND EXCERPTED FROM CAYLEY (1995), REFER ATTACHMENT 1 FOR FURTHER DETAILS

Qra	Alluvium: deposits of existing streams.
Qrm	Lacustrine deposits in swamps and lakes.
Qx	Landslide deposits
Qpc	Dissected colluvium: deposits formed at the toe of slopes by rockfalls, weathering and erosion.
Qrt	Alluvial terraces
Qp	Older alluvial terraces: deposits of valley backfilling following the eruption of Qvn laval flows
Qs	Basalt deposits from lava flows
Qvn	White Hills Gravel: dissected fluvial braid gravel
Tlw	Marine turbiditic sandstone and minor mudstone
€ -Csp	Marine turbiditic interbedded siltstone, mudstone and minor sandstone
€ -Csb	Initial alignment options provided by BECA

N
W E
S

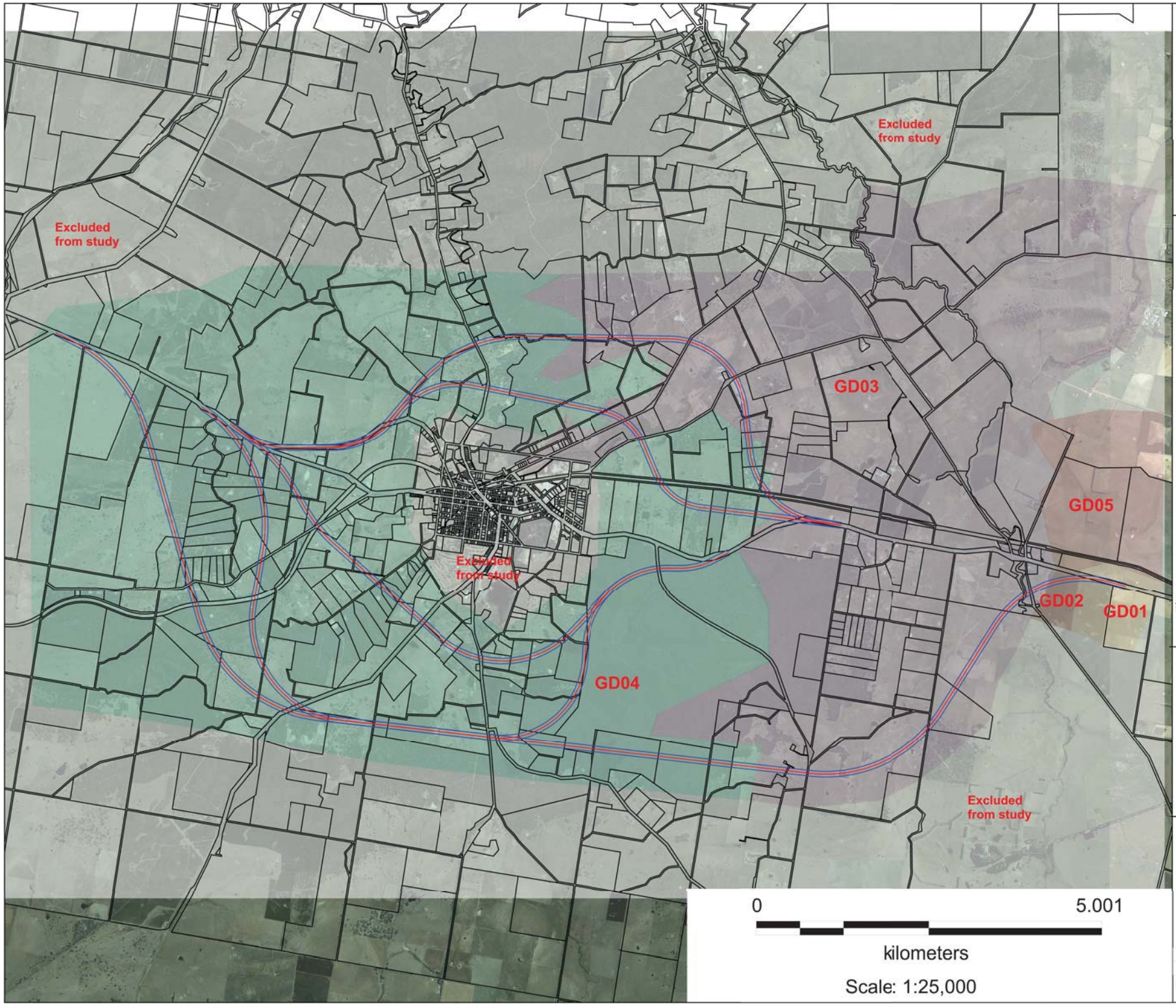
DATUM: MGA94
PROJECTION: Zone 54

DATA SOURCE: Geological Base Map Extracted from Cayley, (1995), Provided as Attachment 1

Client:	BECA
Project:	BECA ARARAT - BEAUFORT STUDY
Title:	Beaufort Bypass - Expected Geology
Plot size:	A1
Job Number:	JEXBEC
Figure:	1

Rev	Date	By	Approved
A	06-05-2011	HO	AD

Report: JEXBEC-R002



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LEGEND

GD01 Fluvial gravel and colluvium may require adoption of shallower cutting angles

GD02 Basaltic soils over basalt, variable weathering profile and potential for harder basalt layers at depth requiring ripping or blasting, soils have high shrink-swell potential

GD03 Low lying flood plain deposits, potential lenses of soft soil, bridges and culverts required for low points and creeks, susceptible to flooding

GD04 Sandstone mudstone and siltstone with colluvium and terraces of alluvial sediments. Cuttings may intersect elevated terrace of unconsolidated sediments. Several minor creeks requiring bridges of culverts. The southernmost alignment options traverse through several farm dams and houses. Potential for small scale landslips to affect cutting and embankment stability.

GD05 Mixed domain of basaltic soils and swamp/lacustrine deposites. Basaltic soils have high shrink-swell potential. Swamp/lacustrine deposits may be highly compressible requiring significant ground improvement.

Initial alignment options provided by BECA

For more detail on domains see Beaufort Bypass Geotechnical Desktop Study

N
W E
S

DATUM: MGA94
PROJECTION: Zone 54

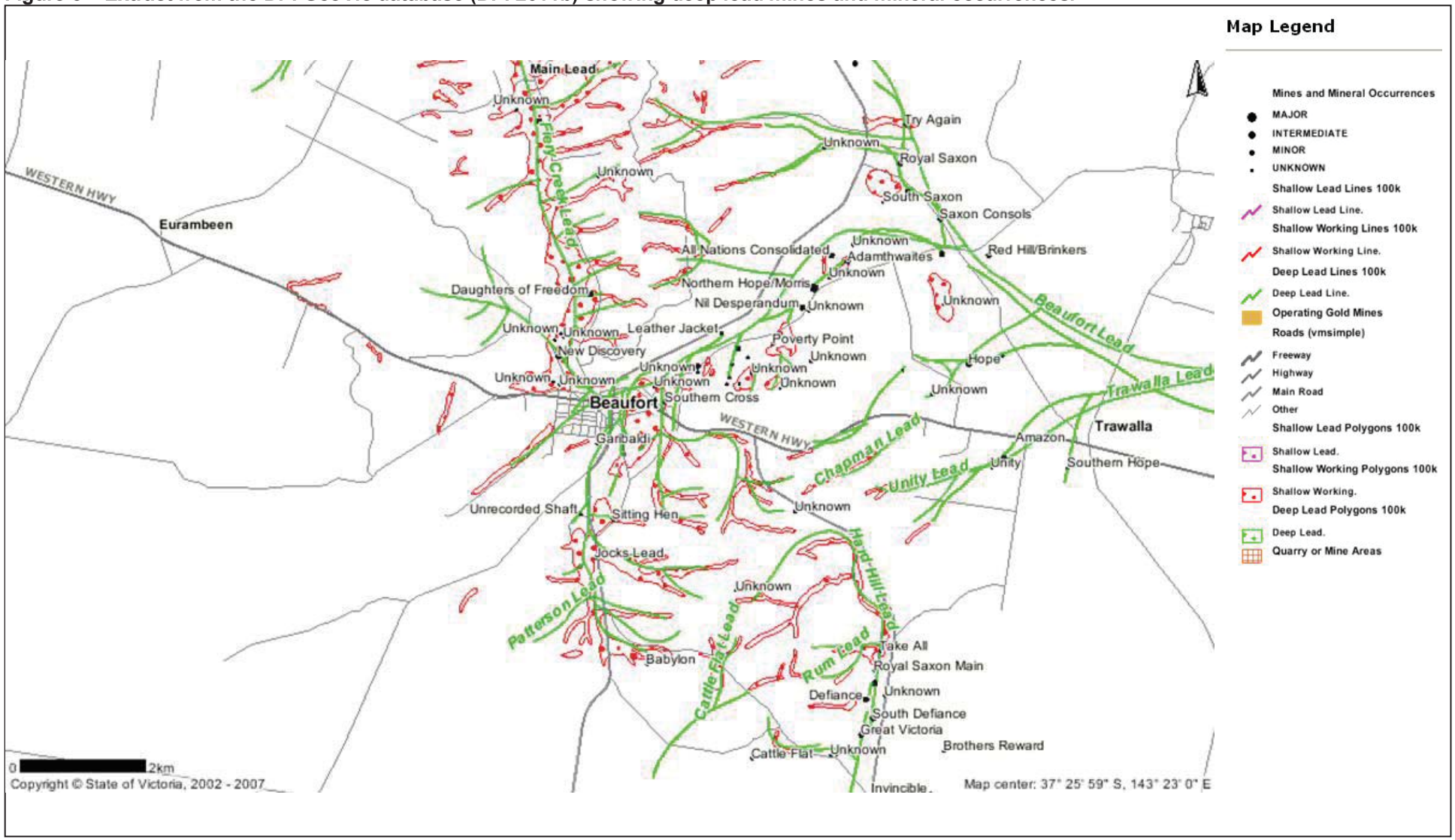
DATA SOURCE: Google Earth Professional
Geological base map extracted from geological survey of Victoria

Client:	BECA
Project:	BECA ARARAT - BEAUFORT STUDY
Title:	Beaufort Bypass - Geotechnical Risks
Paper Size:	A1
Job Number:	JEXBEC
Figure:	2

Rev	Date	By	Approved
B	06-05-2011	HO	AD

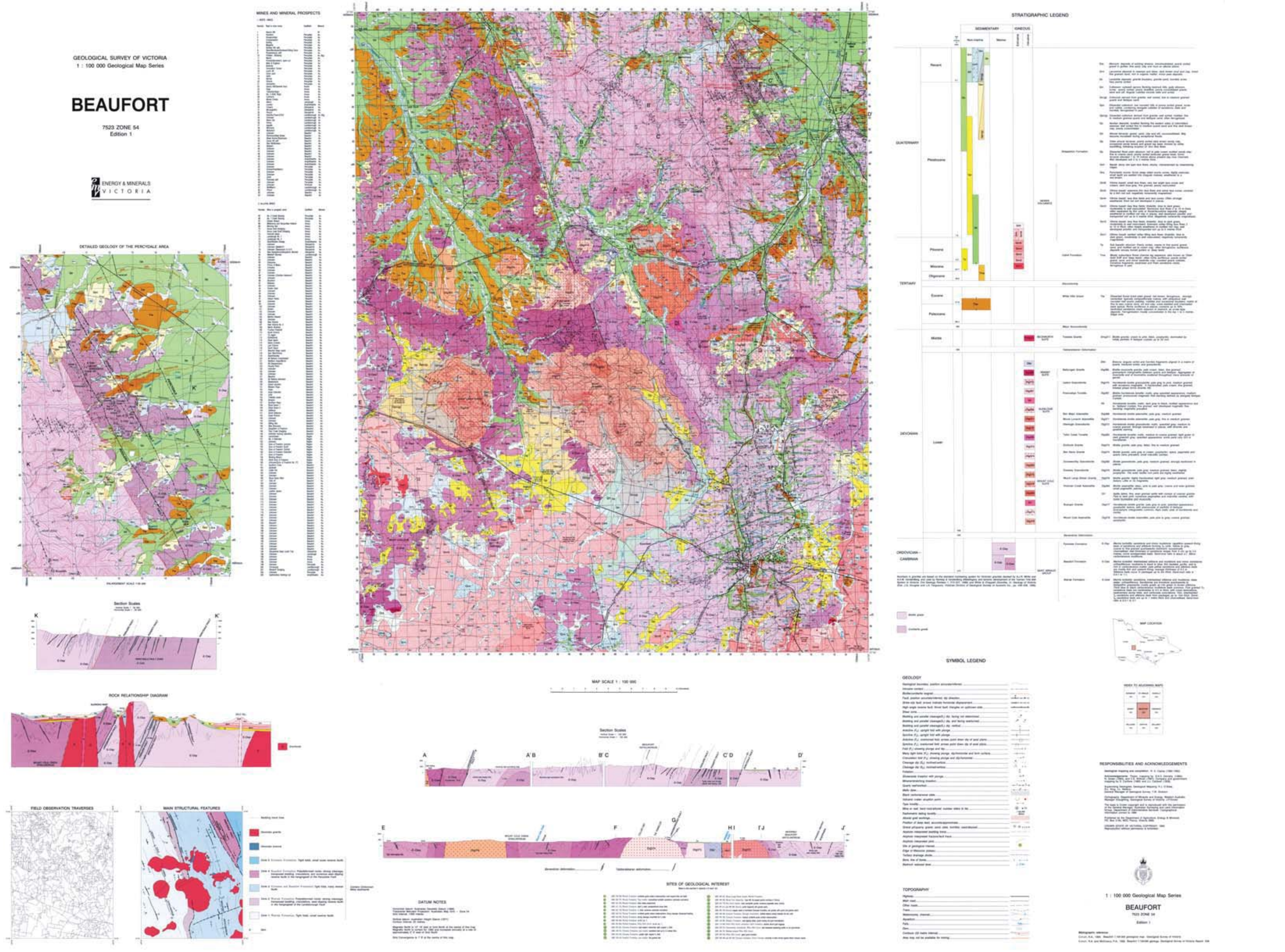
Report: JEXBEC-R002

Figure 3 – Extract from the DPI GeoVic database (DPI 2011b) showing deep lead mines and mineral occurrences.



Attachments

Attachment 1: Beaufort 1:100 000 Map Geological, Geological Survey of Victoria, 1995



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Appendix B

Preliminary Concept Estimate

Appendix C

Public Acquisition Estimate