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Australian Rail Track Corporation

Minimbah Third Track

Project Application Report

March 2008

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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1. Introduction

1.1 Background

On 5 September 2004, the Australian Rail Track Corporation (ARTC) commenced a 60 year lease of the interstate and Hunter Valley rail lines of New South Wales. Since commencing this lease, the Hunter Valley network aspects have been reviewed and updated by ARTC in light of rapid growth in coal demand. This has resulted in the development of the Hunter Valley Corridor 2007 – 2012 Capacity Strategy Consultation Document (the Strategy).

At present, export coal capacity of the Hunter Valley rail network averages around 107 million tonnes per annum (mtpa). Current industry forecasts indicate demand on the Hunter Valley rail network will increase to 165 mtpa by September 2009. PWCS and the Newcastle Coal Infrastructure Group (NCIG) are currently increasing the export capacity of the Port of Newcastle to meet this demand. ARTC is therefore implementing a strategy of line improvements endeavouring to keep the rail system capacity ahead of industry demands. Design and construction of the Minimbah Bank Third Track is a key component in meeting the objectives of the Strategy.

Minimbah Bank is located approximately 10 km south of Singleton on the Main North Line, extends from Belford to north of Whittingham Junction, and is one of only three sections of track on the Main North line with headways in excess of 10 minutes. To cater for the increased line capacity specified in the Strategy, the existing headway of approximately 14 minutes needs to be reduced to 8 minutes in order to achieve the required 165 mtpa coal carrying capacity requirement at Minimbah Bank.

Due to the steep grade of Minimbah Bank (approximately 1:80), loaded coal trains are unable to negotiate the Bank at sufficient speeds creating the current headway of 14 minutes. The steep grade also results in trains stalling on the Bank creating severe service disruptions, increased rail wear and reduced line capacity. As 95% of coal trains in the Hunter Valley negotiate Minimbah Bank, this problem has significant impacts to the current and future line capacity.

ARTC proposes that the Minimbah Bank Third Track project be complete by March 2010.

1.2 The Project

The proposed Minimbah Bank Third Track project (herewith described as the Project), consists of a third track adjacent to the existing Up main line at a revised grade of 1:100 in comparison to the grade of the existing main line of 1:80. The major elements of the third track include approximately 10.8 km of track and earthworks, 3 new rail under bridges, grade separation of Range Road level crossing, replacement and realignment of the Golden Highway overbridge, services relocation, signalling works and property acquisition.

1.3 Purpose Of This Report

This Project Application Report has been prepared to supplement the Project Application Form submitted to the Director-General of the Department of Planning (DoP) requesting the Director-General's Requirements for an Environmental Assessment of the Project (as described in Section 1.2) in accordance with Section 75E of Part 3A of the EP&A Act.

GHD has been commissioned by the ARTC to undertake the necessary environmental assessment and assist ARTC in achieving the necessary environmental and planning approvals for the Project.

Under Clause 6 of the State Environmental Planning Policy: Major Projects (Major Projects SEPP) "*development that has a capital investment value of more than $30 million for the purpose of heavy railway lines associated with mining, extractive industries or other industry*" (as listed in Clause 23 of Schedule 1) qualifies as a major project requiring determination the Minister for Planning under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). As the Project is a heavy rail line project associated with the mining industry with a value of approximately $100 million, the Project qualifies as a major project requiring approval under Part 3A of the EP&A Act.

In accordance with Section 75F(2) of the EP&A Act, it is anticipated that the information in this Project Application Report will be used by the DoP to prepare formal requirements for the environmental assessment of the Project.

2. Route Options Assessment

In selecting the preferred route to be the basis of the Project, there were two stages of route option identification and assessment.

2.1 Stage 1 – Options Evaluation and Identification of Preferred Options

Stage 1 of the process consisted of identification and evaluation of eight (8) possible options. Based on a constraints analysis and optimization against a range of evaluation criteria in workshops with ARTC and project stakeholders, three (3) preferred options were selected to progress to the Stage 2 evaluation.

2.2 Stage 2 –Preferred Option Selection

Originally, the primary purpose of Stage 2 was to progress engineering of key elements of the preferred options enabling the refinement of capital cost estimates and selection of a preferred option. In progressing this original scope, a number of issues arose altering the assessment criteria and therefore the delivery method of the Project. Specifically, these relate to the refinement of previously agreed junction configurations (and associated operational issues). Consideration of the potential environmental and social issues of the three (3) options was also undertaken and incorporated into the evaluation process. The alteration of the assessment criteria enabled the early selection and recommendation of a preferred option.

The preferred option was agreed with ARTC resulting in GHD progressing a robust concept design of a single option.

3. Project Description

3.1 Site Location

The Project site is located within the Singleton Local Government Area (LGA) adjacent to the existing Main Northern Railway. It commences in an area known as Minimbah approximately 16 km south of Singleton and continues north for approximately 10.8 km to an area known as Whittingham (chainage 224.220 km and 235.070 km).

The land uses adjoining the Project site are predominantly rural, particularly grazing land, and associated rural residences. The New England Highway is located to the east of the Main Northern Railway, running parallel and in close proximity to the Project site. Several public roads and private accessways cross the Main Northern Railway/ Project site, including the Golden Highway (via a bridge), Range Road (via a level crossing) and a private level crossing at chainage 231.180 km. Adjacent to the northern section of the Project site is a privately owned airstrip, while a nursery and landscaping supplies business is located between the New England Highway and the Main Northern Railway approximately 2 km south of Whittingham.

The Project site is illustrated in Figure 3-1.

3.2 Project Outline

3.2.1 Alignment

The Project would run adjacent to the Up main at a maximum grade of 1:100. The Project would begin at chainage 235.070 km and rejoin the main line at chainage 224.220 km.

The Project is designed at a minimum of 6.5 m track centres to the existing Up main, which increases to a maximum of approximately 18.5 m due to batter slope requirements. Between chainages 235.070 km and 231.340 km the Project would be at the same grade as the existing main. At chainage 231.340 km the 1:100 grade commences with the new Up Main rising higher than the existing main line, resulting in the Project being on a fill batter at a maximum height of 3.5 m above the existing main line.

The difference in the grade of the Project and existing main line grades is illustrated in **Figure 3-2**.

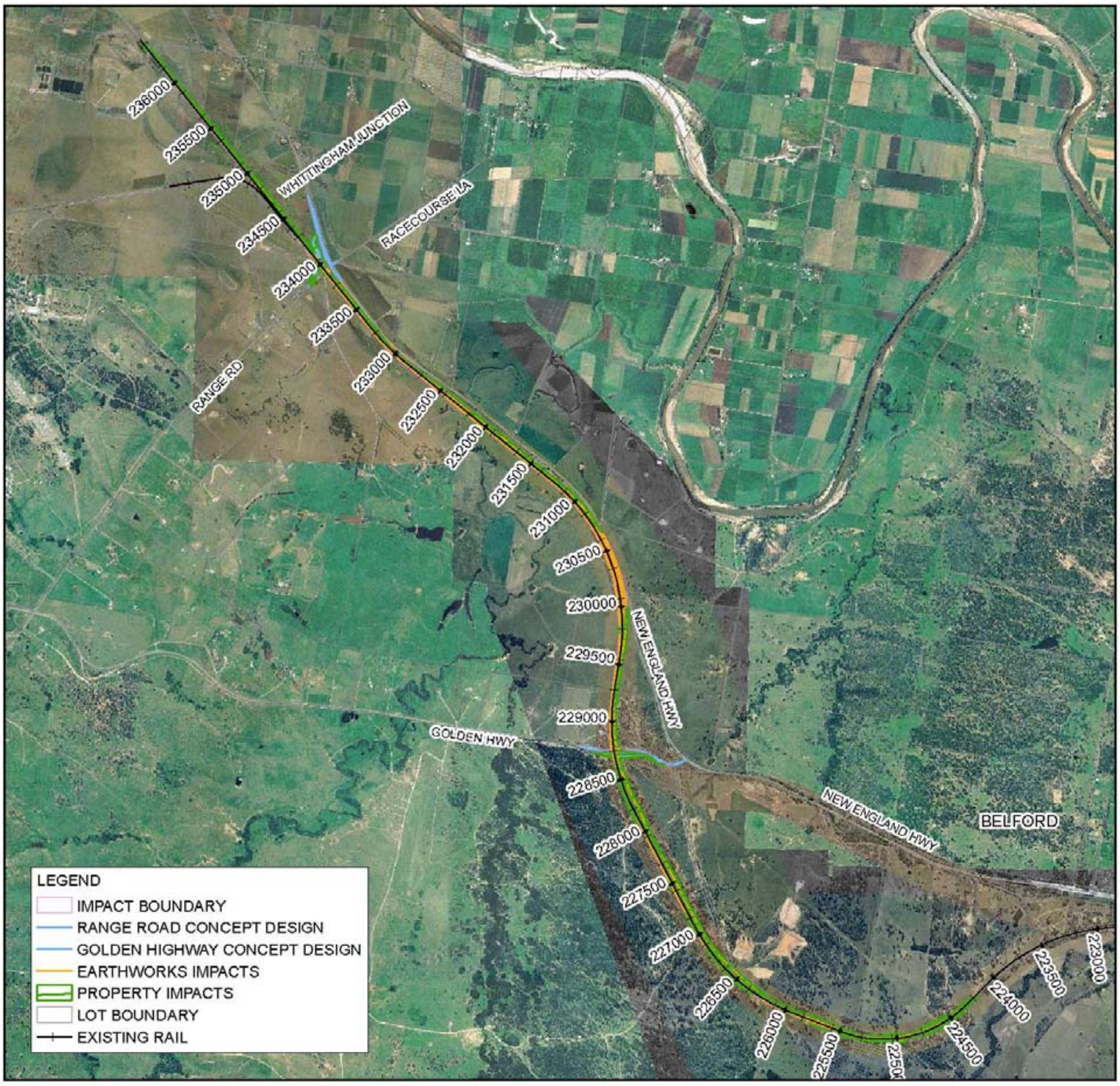

Figure 3-1 The Project Site

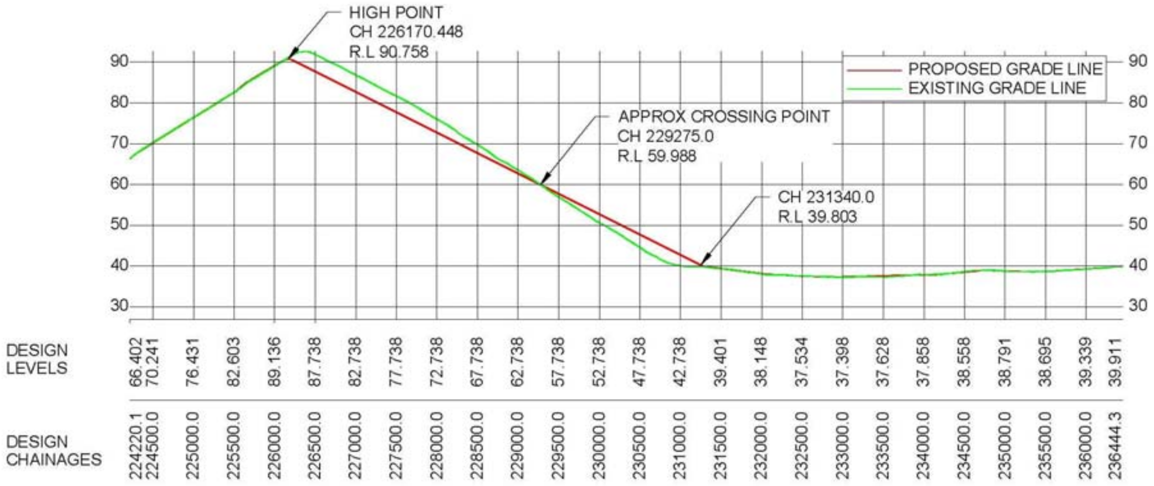

Figure 3-2 Long Section of Existing Up Main and Proposed New Up Main

At approximate chainage 229.275 km the Project and existing main line grades are at a common level of 1:80. At this location, the new Project drops lower than the main line, resulting in the new Up Main being in a cut at a maximum depth of 4.25 m below the existing main line.

By approximate chainage 226.170 km the grades of the new Up Main and existing main line are again level with the new Up Main re-joining the main line at chainage 224.221 km.

3.2.2 Major Infrastructure Elements

Major infrastructure elements included in the concept design are as follows:

- Approximately 10.8 km of track including turnouts, junctions and signalling;
- Approximately 10.8 km of earthworks including drainage and minor structures;
- Rail under bridge (major culvert) at chainage 236.472 km;
- Mudies Creek rail under bridge at chainage 232.167 km;
- Golden Highway over bridge and associated road works at chainage 228.790 km;
- Grade separation of Range Road level crossing at chainage 233.958 km;
- Proposed closure of a private level crossing at chainage 231.180 km with provision for alternate private access; and
- Retaining wall approximately 3 m high x 465 m long between chainages 230.215 km and 230.675 km to retain the third track fill batter from encroaching on the New England Highway road reserve.

3.2.3 Enabling Works

Services relocations to facilitate construction of the Project will be undertaken separately and assessed under Part 5 of the *Environmental Planning and Assessment Act 1979* and the ARTC Code of Practice. Services relocations will include communications, railway signalling, power and local irrigation pipelines.

Further details on the services to be relocated are included in Concept Design Report, contained in Appendix A.

3.2.4 Proposed Track Configuration

The proposed configuration for the Minimbah Bank Third Track project is illustrated in Figure 3-3 below:

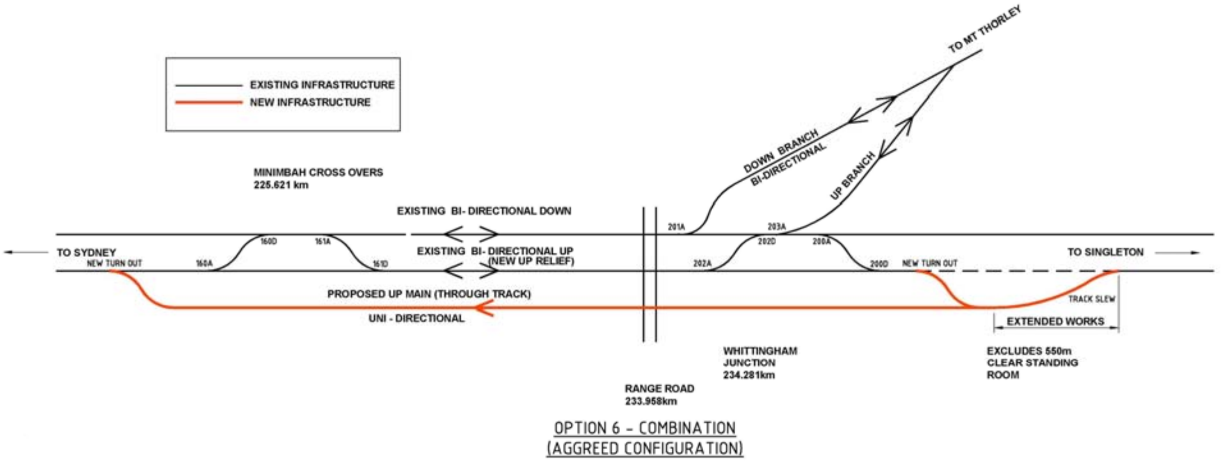

Figure 3-3 Proposed Configuration

3.2.5 Typical Cross Sections

To enable the third track to be constructed adjacent to the existing mainline at a revised grade of 1:100, the Project requires earthworks formations at grade, in cut and in fill. Typical cross sections illustrating these earthworks scenarios are illustrated in Figure 3-4, Figure 3-5 and Figure 3-6.

Figure 3-4 Type 1 Cross Section – Extended Formation (At Grade)

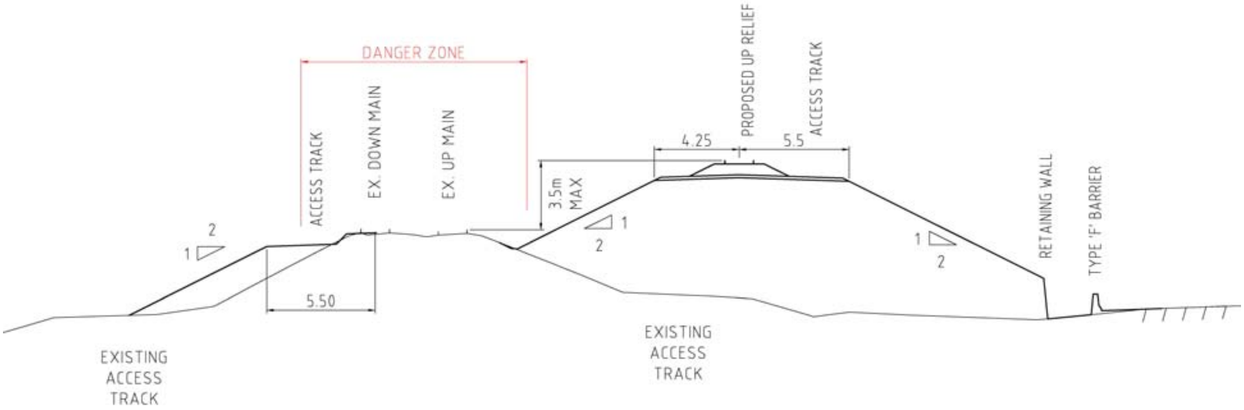

Figure 3-5 Type 2 Cross Section – Embankment to Formation (In Fill)

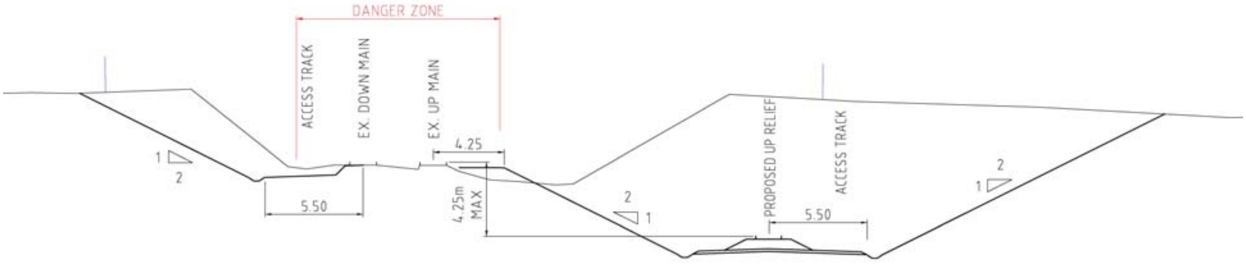

Figure 3-6 Type 3 Cross Section – In Cut

3.2.6 Bulk Earthworks Requirements

Bulk earthworks requirements for the third track are summarised as follows:

Third Track

The bulk earthworks figures are as follows:

- Cut – 443,400 m^3;
- Fill – 238,200 m^3;
- Capping – 17,400 m^3;
- Maximum cut depth – 10.3 m; and
- Maximum fill depth – 8.8 m.

Golden Highway Road Re-Alignment

- Cut – 1,800 m^3; and
- Fill – 63,000 m^3.

Range Road

- Cut – 0 m^3; and
- Fill – 80,000 m^3.

Downside Access Track

- Cut – 59,400 m^3;
- Fill – 44,700 m^3; and
- Capping – 7,000 $m^{3.}$

3.2.7 Concept Design

For detailed discussion of other elements of the proposed third track design, refer to the Concept Design Report, contained in Appendix A.

4. Planning Issues

4.1 Local Planning

The Project is located within the Singleton Local Government Area (LGA) which is covered by the Singleton Local Environmental Plan 1996 (the LEP). Under the LEP, the Project route passes through land zoned as follows:

- 1(a) – Rural: under this zone, rail infrastructure is permissible with development consent;
- 5 – Special Uses (Defence): under this zone, roads and utility installations are permissible with development consent, however rail infrastructure is not listed as permissible.

  However, as discussed in Section 4.2, the Infrastructure SEPP permits rail infrastructure on any land without development consent; and
- Unzoned (rail and road corridors): the Main Northern Railway, Range Road, Golden Highway and New England Highway corridors are unzoned under the LEP.

4.2 State Planning Considerations

State Environmental Planning Policy (Infrastructure)

Clause 79 of the State Environmental Planning Policy (Infrastructure) (Infrastructure SEPP) states that:

"*Development permitted without consent—rail infrastructure facilities generally*

(1) Development for the purpose of a railway or rail infrastructure facilities may be carried out by or on behalf of a public authority without consent on any land."

Therefore, under Clause 79 of the Infrastructure SEPP, the Project is permissible.

State Environmental Planning Policy (Major Projects)

Under Clause 6 of the State Environmental Planning Policy (Major Projects) (Major Projects SEPP) the Project is considered a Major Project as it meets the following definition under Schedule 1 of the Major Project SEPP:

"*23 Rail and related transport facilities*

(1) Development that has a capital investment value of more than $30 million for the purpose of:

(a) heavy railway lines associated with mining, extractive industries or other industry."

As such, it is to be assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and submitted for approval by the Minister for Planning.

4.3 Environment Protection and Biodiversity Conservation Act 1999

Consideration of the matters of National Environmental Significance (NES), and therefore whether the Project is potentially a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, would be undertaken as part of the Environmental Assessment. However, the preliminary assessment undertaken indicates that the Project may not constitute a controlled action due to the following:

- The Flora and Fauna Route Options and Constraints Assessment (Ecotone 2007) did not identify the potential for significant impacts on threatened species or endangered ecological communities, migratory species;
- There are no World Heritage Areas or wetlands of international significance within the vicinity of the Project route, or likely to be impacted by the Project;
- The Project does not involve a nuclear action;
- While there is one item listed on the register of the National Estate (Minimbah House), it is unlikely to be adversely impacted by the Project;
- While the Project proposes to undertake works within land that is currently Commonwealth land (Defence property):
  - It is to be purchased from the Commonwealth prior to undertaking the works, therefore it would not be deemed Commonwealth land; and
  - It is considered unlikely that works on this land would constitute a significant impact.
- While the Australian Rail Track Corporation (ARTC) is a Commonwealth agency, it is considered unlikely that the Project would have a significant impact on the environment.

As such, at this stage it is considered unlikely that the Project would constitute a controlled action under the EPBC Act and therefore does not trigger the bilateral agreement with the Commonwealth Department for the Environment, Water, Heritage and the Arts (DEWHA).

5. Preliminary Environmental Assessment

5.1 Introduction

A Preliminary Environmental Assessment was undertaken of the three main route options considered for the Project (GHD, 2007). The following discusses the main environmental issues identified by the Preliminary Environmental Assessment for the route that was selected for the Project, as well as other potential environmental issues that should be considered.

5.2 Noise and Vibration

The Project would involve widening of the existing corridor. While the area surrounding the Project site is already dominated by rail traffic, the Project would involve the construction of rail lines and road infrastructure (such as the Range Road overpass) closer to existing sensitive receptors than the current situation.

This has the potential to increase noise and vibration levels at a number of these receptors, during both the construction and operation phases.

Potentially sensitive receptors adjacent to the Project are primarily rural residences scattered throughout the adjoining rural properties, however several residences are located to the south of the crossing of the Project route with Range Road, and to the southwest of the crossing of the Project route with the Golden Highway. Other residences are scattered throughout the rural properties to the north and south of the Project route.

5.3 Aboriginal Heritage

A review of records of known Aboriginal heritage sites registered with the Aboriginal Heritage Information Management System (AHIMS) found that there are 58 previously recorded sites within four (4) km of the Project route, including three (3) sites located within 100 m of the Project route.

While much of the Project route has been subject to disturbance, much of that disturbance has been limited to vegetation clearance. Therefore based on these conditions, and the high number of recorded Aboriginal sites within close proximity of the Project route, there is potential for Aboriginal sites to be present within remaining undisturbed topsoils.

Consultation with Aboriginal stakeholders in accordance with the DECC policy entitled *Interim Community Consultation Requirements for Applicants* has commenced, with ten Aboriginal stakeholders registering interest in the Project.

5.4 Non-Indigenous Heritage

The Project route and its surrounds have been subject to non-indigenous activity and settlement since the early 19th Century, with five historical homesteads and non-indigenous heritage items registered on local or state heritage registers located within approximately two (2) kilometres of the Project site.

These items include:

- Minimbah House;
- Baroona (Homestead);
- Neotsfield (Homestead);
- Gates and Gate Lodge; and
- Church of the Good Shepherd.

The nearest item is Baroona, which is approximately 600 metres to the southwest of the Project.

Due to the distance of these heritage items from the Project route, it is unlikely that the Project would have any direct or indirect impacts on these items.

5.5 Flora and Fauna

Vegetation within the Project site has been heavily disturbed due to vegetation clearance and earthworks within the existing Main Northern Railway corridor and the areas adjoining the rail corridor. The vegetation adjacent to the corridor primarily consists of grassed areas and scattered trees.

A Flora and Fauna Route Options and Constraints Assessment (Ecotone, 2007) found that the Project site could result in negligible to minor impacts on two (2) endangered ecological communities, potentially impact on two (2) threatened flora species and could lead to increased fauna habitat fragmentation. However, the assessment concluded that the Project would lead to a relatively low ecological impact.

A copy of the Flora and Fauna Route Options and Constraints Assessment is included in Appendix B.

5.6 Air Quality

The Project would involve widening of the existing corridor rather than construction of a new corridor. While operation is unlikely to result in an increase in air emissions, construction works would potentially generate dust from earthworks and emissions from construction machinery.

5.7 Social and Economic Impacts

The Project would generate social impacts to some local residents, as the Project requires acquisition of private land (the extent of which is to be confirmed), the closure of a private rail crossing, and temporary and permanent alterations to vehicle access. The previously discussed issues could also impact on the local community. Section 6 outlines the stakeholder consultation process that ARTC and GHD are implementing to identify the potential social issues.

The Project would create an overall positive economic impact, as its operation would allow increased line coal carrying capacity, while its construction would result in direct employment opportunities and benefit local and regional goods and services providers.

5.8 Hydrology

Investigations were completed into the flooding levels of Mudies Creek to determine maximum storm events for the access road. Using an idealised channel shape underneath Mudies Creek Underbridge, the 50-year storm event came up to an RL of 31.5 m, which provides a clearance of 4.7 m to the soffit of the bridge girder. This is sufficient clearance for this area.

The Project route crosses several watercourses (such as Mudies Creek and several unnamed drainage lines), with existing drainage infrastructure (such as culverts) included in the existing rail corridor. The Project also requires some limited filling within the Hunter River floodplain for the third track, as well as for the Range Road overpass.

Further investigations would be undertaken into the drainage between the tracks and the New England Highway to the east of Mudies Creek. Further investigations will also be undertaken of the potential impact of the Project on flooding in the local area using the existing flood model developed on behalf of Singleton Council.

5.9 Energy and Greenhouse

Some short-term greenhouse gases would be emitted during the construction of the Project as a result of the construction machinery and vehicles. However, a preliminary assessment estimated that approximately 1,300 L less fuel would be used per million tonnes of coal as a result of the Project compared to the existing situation, which would result in a corresponding reduction in greenhouse gas emissions per tonne of coal transported through the Project route.

The greenhouse gases that would be emitted during the construction of the Project include:

- Carbon Dioxide (CO2);
- Carbon Monoxide (C0);
- Oxides of Nitrogen (NOx); and
- Non-methane Volatile organic Compounds (NMVOC).

5.10 Soils and Geology

Construction of the Project would require major earthworks, with excavation required in the southern section of the Project route, and filling required at the northern end of the Project route. Adequate management of these earthworks would be required to prevent erosion and sediment loss, and adversely impact upon downstream watercourses.

A Geotechnical Assessment is currently being undertaken of the Project route to assess the existing soil and geotechnical conditions.

6. Proposed Environmental Assessment Scope of Works

6.1 Environmental Assessment

Based on the results of the Preliminary Environmental Assessment and GHD's experience in environmental assessment of similar projects, GHD proposes the following Scope of Works for the Environmental Assessment (EA).

6.1.1 Strategic Justification and Project

The EA would outline the strategic outcomes of the Hunter Valley Coal Network Capacity Improvement Strategy, including the strategic need and justification, the aims and objectives of various State planning policies, and the cumulative impacts of the Strategy as a whole. GHD would discuss how the Project fits in with the Strategy and how Project impacts can be managed as part of the overall Hunter Valley Coal Network.

6.1.2 Project Justification

The EA would describe the need for and objectives of the Project both as it fits into the Hunter Valley Coal Network Capacity Improvement Strategy and on a localised level. This would include discussion of the considered alternatives and a justification of the preferred option (the Project).

6.1.3 Land Use and Property

The EA would discuss the following with regard to the land uses and properties affected by the Project:

- The properties and land uses directly affected by and adjacent to the Project route, including identification of any areas identified as regional and State significant farmland;
- The potential impacts on the viability of these land uses (such as from land sterilisation and severance impacts) caused by the Project; and
- Impacts on connectivity and access resulting from the Project.

6.1.4 Noise and Vibration

ARTC would undertake a noise and vibration assessment as part of the EA that includes the following:

- Initial desk top review to identify key environmental noise and vibration catchment areas and sensitive receptors from aerial photography;
- Undertake a site visit to identify appropriate noise monitoring locations; and

- Upon initial review of the latest proposed alignments and sensitive receptor maps based on our experience of similar size projects, undertake unattended monitoring for a period of one (1) week at six (6) locations for noise and three (3) locations for vibration.

It is anticipated the monitoring will be conducted using three (3) noise and three (3) vibration loggers with one (1) weather station at a location indicative of the local ambient noise environment that can potentially be affected by the Project.

- Undertake attended measurements at the unattended logging locations to supplement the unattended measurements and determine pass by rail noise and vibration levels;
- Noise and vibration data would be assessed and filtered to remove invalid data due to extraneous noise or adverse weather conditions;
- Based on monitoring results, establish project specific noise and vibration goals for the construction and operation of the Project with consideration to the following publications:
  - Department of Environment and Climate Change (DECC) *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects* (2007);
  - DECC *Environmental Noise Control Manual* (1994); and
  - DECC *Assessing Vibration: A Technical Guideline* (2006).
- Identify the likely principal noise and vibration sources during construction and operation and their potential impacts on noise sensitive receptors; and
- Undertake one noise-modelling scenario of the preferred option for the following situations using Computer Aided Noise Abatement (CadnaA) software to predict sound pressure levels emanating from Project:
  - Existing situation;
  - Track construction;
  - Operations at commencement date; and
  - Operations 10 years after commencement date.

A report would be prepared with consideration to the above mentioned methodology and guidelines, detailing the results of the noise and vibration monitoring and impact assessment including:

- A brief description of the Project;
- A brief description of the ambient noise environment;
- A brief description of the items to be used on site likely to emit noise;
- Location of the closest noise and vibration sensitive receiver(s) with respect to the Project;
- Charts of the noise parameters including, Lmax, LA10, LA90, and LAeq for the unattended noise monitoring;
- Details of noise and vibration of passby measurements;
- Discussion of the noise and vibration impact and modelling assessment results with relation to the adopted noise goals; and
- Mentioning possible in-principle noise and vibration mitigation measures if the assessment suggests that Project specific noise goals may be exceeded.

6.1.5 Indigenous Heritage

ARTC would use its Aboriginal heritage subconsultant, South East Archaeology, to undertake the Aboriginal Heritage Assessment. The Assessment would involve the following key stages and tasks.

Preliminary Investigation

- Undertake a search of the DECC Aboriginal Heritage Information Management System and other relevant indigenous heritage registers and planning instruments;
- Undertake research into the archaeological and environmental context of the Project route;
- Develop a predictive model of site location for the Project route;
- Obtain from the client relevant information and prepare mapping for the field survey; and
- Identify and contact the relevant Aboriginal organisations to discuss the project and make arrangements to undertake a field inspection, in accordance with the DECC policy entitled Interim Community Consultation Requirements for Applicants, and in all instances after approval from the client's Project Manager. This involves providing written notification and requesting expressions of interest from Aboriginal people by placing an advertisement in the local print media, contacting in writing the Local Aboriginal Land Council, DECC, Registrar of Aboriginal Owners (Department of Aboriginal Affairs), NSW Native Title Services and relevant Local Council, with a minimum 10 day response period. The process must be repeated for any Aboriginal persons/organisations identified by the above parties. Detailed information must then be forwarded to those Aboriginal persons/organisations who register their interest, with an additional 21-day response period for comments, prior to the field investigation.

Field Investigation

South East Archaeology would undertake a field survey of the Project site involving:

- A team comprising archaeologists qualified in Aboriginal heritage and Aboriginal community representatives (approved by the client) walking systematically across the study area, obtaining a sample of every environmental unit identified within this area;
- The extent of survey coverage dependent upon conditions of surface visibility, levels of ground disturbance and artefact densities;
- Detailed recording of every transect surveyed, including environmental conditions (such as landform unit, slope, surface visibility, detection limiting factors, levels of ground disturbance) and Aboriginal heritage resources identified or potentially present;
- Recording of all Aboriginal heritage sites identified (including the extent of visible artefacts, surface visibility, detection limiting factors, other environmental conditions, and artefact and stone material types); and
- Consultation with the Aboriginal representatives during the course of the survey regarding oral history and landscape features, places and natural resources of interest to the Aboriginal community.

Analysis and Report Preparation

The consultant will:

- Complete and submit site records to DECC;
- Document Aboriginal consultation and provide registered Aboriginal stakeholders and the LALC with a copy of the draft report (after its prior approval by the Project Manager) and address their responses within a final report, in accordance with the DECC policy entitled Interim Community Consultation Requirements for Applicants; and
- Prepare a report to meet the standards required by DECC. The significance of any sites identified would be assessed and recommendations presented for their management. A draft report would be provided and revised in relation to input from the client and the registered Aboriginal stakeholders. Copies of the final report would be submitted after approval to the registered Aboriginal stakeholders.

6.1.6 Flora and Fauna

Ecotone Ecological Consultants (Ecotone) has undertaken investigations on behalf of ARTC within the area to assist with the route selection process. Ecotone has identified some patches of vegetation within 125 m of the existing tracks that are potentially modified forms of one or more Endangered Ecological Communities.

Ecotone would supplement the findings of their recent investigations with the following:

- Investigate the remaining sections of the Project route;
- To fully document the relative condition of vegetation communities and habitats present and to target threatened species potentially present;
- Prepare a Constraints Report that addresses the whole study corridor based on Flora and Fauna constraints; and
- Prepare a Flora and Fauna Impact Assessment Report, including the 7-part test of Section 5A of the EP&A Act.

The assessment would be prepared in accordance with the draft DECC *Guidelines for Threatened Species Assessment*.

6.1.7 Hydrology and Flooding

A preliminary review of the Singleton Council Floodplain Management Plan Development Control Plan (DCP), indicates that the Project lies, in part, within the floodplain surrounding the township of Singleton. Within this DCP, it is noted that there is a high hazard floodway encircling the town where water flows from the Hunter River through Doughboy Hollow and rejoins the Hunter River downstream of Singleton. This is the area in which the Project works would occur.

The DCP also indicates that no building or landfilling shall be permitted within the floodway as indicated on the Flood Inundation and Hazard Map. However, landfilling in flood fringe areas may be permitted after consideration is given to the impact on flood behaviour, potential damage to other properties, fill material and potential for contamination of floodwaters.

As discussed in Section 5.8, further investigations will also be undertaken of the potential impact of the Project on flooding in the local area using the existing flood model developed on behalf of Singleton Council. The model would be reworked to include the potential impacts of filling within the floodplain associated with the Project.

With the limitations placed on the Project development, GHD would undertake a review of the potential hydrology and hydraulic impacts by:

- Reviewing the existing Singleton Council Floodplain Management Plan DCP;
- Reviewing existing flood studies available from Singleton Council for the Project route covered by the DCP;
- Determining the extent of encroachment of the Project works into the flood fringe and floodway areas of the floodplain; and
- Providing recommendations on the likely requirements for any further investigations resulting from the above.

With respect to general stormwater impacts, GHD proposes to:

- Review the location and size of existing waterway crossings;
- Examine the location and size of additional crossings of these waterways;
- Provide comment on the impact of the proposed waterway crossing;
- Review the proposed rail alignment and the potential location of additional waterway crossings;
- Assess the impact of these additional crossings on the existing hydrologic and hydraulic regime using Probabilistic Rational Method, Culvert-W and specifically developed Excel spreadsheets; and
- Comment on the potential hydrologic and hydraulic impact of the proposed works on adjacent properties.

6.1.8 Visual Amenity

The visual assessment would assess current conditions and consider the following:

- A description of the visual characteristics of the Project route and surrounding area, including visual context of the Project route (where it fits with the surrounding landscape and land uses);
- Identification of the approximate viewshed. GHD would utilise topographic data in the GIS system to determine the areas of the surrounding environment could view the Project route;
- An assessment of potential visual impacts of the Project. The assessment would focus on viewpoints identified as sensitive, and what would be seen from them; and
- A description of potential mitigation measures to address visual impacts, such as development types and visual buffers.

6.1.9 Contamination

Due to the historical nature of the land uses within the Project route (agricultural, rail and filling) there is potential for contaminants to be present. ARTC proposes to undertake a Phase 1 Assessment to obtain a clear understanding of the potential contamination issues relating to the Project route.

This is achieved through a desktop study, which includes a review of the site history, key site features, current infrastructure and environmental features (such as geology and topography). The more information reviewed the better the understanding of the site issues and hence enabling issues to be targeted more effectively. The Scope of the Phase 1 Assessment would include:

- Site history review including review of historical land titles, aerial photographs, Council records, Defence records, Section 149 (2) Certificates, interviews with any available former site owners and adjacent land owners (where appropriate);
- Review of site geology, hydrology, hydrogeology (including groundwater bore search) and topography information;
- Review of any other available documents relating to the site that may be available;
- Review of underground services in the area;
- Undertake a site inspection to identify the key aspects of the site that may be a potential contamination issue, and to identify appropriate sampling locations and any access constraints for intrusive site investigations (if required); and
- Preparation of a report summarising the results of the contamination and hazardous building material assessment and providing recommendations for further investigations and/or management measures (if required). The report would be prepared in accordance with the Guidelines for Consultants Reporting on Contaminated Sites (NSW EPA, 1997) and Occupational Health and Safety Act 2000 and Regulation 2001.

6.1.10 Social and Economic

In assessing the potential social and environmental impacts of the Project ARTC would consider the following:

- The loss of agricultural land, particularly any areas identified as regionally or State significant farmland;
- Local community socio-economic impacts (adverse and beneficial) associated with land use, access, property and amenity related changes; and
- The overall viability, property infrastructure, productivity, sustainability and other associated impacts on businesses resulting from the Project.

6.1.11 Air Quality

The construction or operation of the Project is unlikely to have a major adverse impact on air quality. A preliminary assessment would be undertaken to fully address the potential environmental impacts of the Project. Furthermore, the requirement to undertake an assessment that identifies the cumulative impacts would require an air quality assessment to be undertaken. A desktop assessment is proposed to ascertain the likely impacts on air quality, with a focus on potential construction impacts.

6.1.12 Non-Indigenous Heritage

ARTC proposes the following tasks as part of a preliminary non-indigenous heritage assessment:

- Research and review existing information to identify items of potential heritage significance at the site, including but not limited to sources such as the Australian Heritage Council, Australian Heritage Commission, NSW Heritage Office and Local Government Authority;
- Undertake an inspection of the study area (as part of the Aboriginal heritage field survey) to identify and record to a preliminary level any visible items of potential heritage significance; and
- Report on the results of the investigation, including background research and register searches, identified and potential heritage items, preliminary significance assessment and recommendations.

6.1.13 Planning and Zoning Issues

An assessment of relevant local, regional, state and Commonwealth planning policies would be undertaken to determine their relationship to the Project and to confirm its permissibility. This would include reference to the planning provisions outlined in Section 4.

6.1.14 Energy and Greenhouse

ARTC proposes that the EA would identify potential greenhouse gas emission sources from the construction of the Project, and train movements during the operation phase of the Project, and provide an estimate of construction and operation emissions.

A literature review of the Australian Greenhouse Office Workbook and Inventory will be completed.

6.1.15 Resource Conservation and Waste Management

ARTC would identify the potential waste streams associated with the construction phase, and identify measures to avoid or reduce waste generation, opportunities for reuse or make materials available for recycling.

6.1.16 Groundwater

A desktop groundwater study would be undertaken, which would conform to recommended approaches outlined in the Sydney Coastal Councils Group (SCCG) publication *Groundwater Management Handbook: A Guide for Local Government* (1st edition, September 2006).

The methodology of the groundwater study would involve the following:

- Review available existing information, including geological maps as well as various hydrogeological maps available on the NSW Natural Resource Atlas (a Community Access to Natural Resource Information (CANRI) program internet site) such as Groundwater Availability, Groundwater Vulnerability and Bore Distribution, to identify likely characteristics of the regional aquifer(s). The Groundwater Availability map provides an estimate of the importance of the groundwater resource (in terms of salinity), the Groundwater Vulnerability map indicates the appropriate level of protection required, while the Bore Distribution map identifies neighbouring groundwater users and may provide some groundwater data;
- Based on the desktop review, the following would be established where possible:
  - Indicative background groundwater quality;
  - Existing local hydrogeological characteristics of the aquifer(s), including typical depths to groundwater, groundwater flow direction, hydraulic gradients, groundwater availability and vulnerability, and recharge and discharge areas;
  - Identify whether groundwater is likely to be intercepted during construction; and
  - If necessary, recommend measures to mitigate any impacts.

6.1.17 Environmental Assessment Report

ARTC understands the Department of Planning would require the EA to have a structure similar to the following:

- An Executive Summary;
- A detailed description of the project which includes:
  - The route alignment and corridor width. The extent of the EA will be based on the works impact boundary;
  - Design elements;
  - Potential staging;
  - Ancillary facilities such as compound sites; and
  - Resourcing such as construction material needs, spoil disposal and natural resource consumption including water.
- An assessment of the key issues to include:
  - A description of the existing environment;
  - An assessment of the potential impacts both at the construction and operation stages in accordance with the relevant policies and guidelines. An assessment of the direct and indirect impacts must be considered;
  - A demonstration of how the relevant planning, land use and development matters have been considered; and
  - Descriptions of the measures to avoid, minimise, manage, mitigate, offset and or monitor the impacts, and the residual impacts.
- A draft Statement of Commitments (SoC). The SoC must articulate the desired outcome of the commitment and must be achievable, measurable and where relevant time specific; and
- Certification by the author that the information contained is neither false nor misleading.

The EA and SoC would collate the findings of the key and non-key issues assessment and identify the issue-specific measures to avoid, minimise, manage, mitigate, offset and or monitor the impacts. The SoC would be the actions that ARTC would be committed to implement during the construction and operation of the Project.

6.2 Consultation Process

ARTC proposes to involve an appropriate and justified level of consultation with relevant parties including:

- Local, State or Commonwealth government authorities and service providers, including the Department of Planning (DoP), Department of Environment and Climate Change (DECC), the Department of Primary Industries (DPI), the Department of Water and Energy (DWE), the Roads and Traffic Authority (ARTC), and Singleton Council;
- Specialist interest groups including Local Aboriginal Councils; and
- The public, including affected landowners.

The EA would describe the consultation process, document all community consultation undertaken to date and identify the issues raised (including where they have been addressed in the EA).

To ensure an ‘appropriate and justified level of consultation’, the following items are to be addressed:

- Continued liaison with government stakeholders and attending meetings when required;
- Organising consultation and meetings with landowners affected by further fieldwork investigations;
- Organising material for the exhibition period;
- Attending the staffed display periods; and
- Organising consultation and meetings with other identified stakeholders.

6.2.1 Authority Consultation

Following receipt and review of the DGRs and in addition to the planning focus meeting, ARTC proposes to undertake consultation with the relevant agencies to discuss these requirements, clarify any issues and to gain further understanding of the specifics of their requirements.

The feedback from this consultation would be tabulated and acknowledged where the issue is addressed within the EA.

6.2.2 Stakeholder Groups

Consultation for the Project would focus broadly on the groups of stakeholders listed in Table 6-1, but are not inclusive.

Table 6-1 Stakeholder Groups

Group	Participants
Government Agencies	◗ Statutory agencies (such as Department of Environment and Climate Change, DoP, Department of Water and Energy (DWE), Department of Transport, Department of Primary Industries, Department of Defence, Department of Environment and Water, Heritage and the Arts (DEWHA)); and ◗ Local councils (Singleton Council).
Directly Affected Residents and Businesses (Those Located Around Specific Proposed Structures, Construction Sites etc	◗ Approximately 15 landowners; ◗ The Landscaping business; and ◗ Department of Defence.
Community and Other Stakeholder Ssegments	◗ Coal community (Hunter Valley Coal Chain); ◗ The general local community; ◗ Rail users; ◗ Local community and environmental groups; ◗ Major land holders; ◗ Indigenous community; ◗ Developers; ◗ Local Schools; and ◗ Local Businesses.
Transport and Emergency Services	◗ Freight groups; ◗ Transport groups; and ◗ Emergency Services (Ambulance NSW, NSW Fire Brigades, NSW Police).
General Community	◗ Interested residents of the broader Hunter community.

6.2.3 Our Approach to Stakeholder Understanding and Engagement

The International Association of Public Participation has developed a Public Participation Spectrum framework to assist in identifying the level of participation to be pursued.

IAP2 Public Participation Spectrum

Developed by the International Association for Public Participation

INCREASING LEVEL OF PUBLIC IMPACT

INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
Public Participation Goal:	Public Participation Goal:	Public Participation Goal:	Public Participation Goal:	Public Participation Goal:
To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions.	To obtain public feedback on analysis, alternatives and/or decisions.	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision-making in the hands of the public.

Given the scope and location of works, and our assessment of the likely community responses, ARTC anticipates that it is best that the approach for community engagement be one of informing and consulting with affected landowners. A low key approach to engagement, as seen by the IAP2 spectrum is assumed at this point in time. However the inception meeting and early reactions to the community update may highlight concerns that may not be apparent at this time and that may subsequently require more activities than outlined below.

Table 6-2 Proposed Consultation Activities

Activity	Purpose
Stage 1 *Preparation*	
Stakeholder and Community Scan	ARTC would prepare a list of stakeholders and community groups utilising the above list as a guide that have a potential interest in the project. This would assist in preparing an approach to the consultation and involvement activities and in determining the meetings required.
Community Involvement Plan	Following the inception meeting and confirmation of stakeholders, ARTC would develop the community involvement plan to serve as the framework for the communications and consultation activities.
Community Contact Facilities	Establish dedicated 1800 number, out of hours answering service, email contact facilities, reply paid post address details, and text for project webpage to be included on the ARTC website.

Activity	Purpose
Consultation Manager Database	ARTC would use an access database to manage contacts/complaints and the submission process.
Complaints Management System	ARTC would manage in Consultation Manager database the records of customer complaints and manage response consistent with ARTC consultation management procedures provided in the ARTC Involvement Strategy.
Stage 2 *Preparation of the EA*	
Community Update No.1	ARTC would prepare a community update to provide general and specific information on the project to keep stakeholders and the community accurately informed and encourage feedback.
Letter/Invitations to Directly Affected Residents/Landowners	ARTC would prepare a letter/invitation to be sent residents/landowners directly affected by the Project to notify them of the Project. The letter would explain the route options, current approvals process, and their opportunities for input on the process and project. People would be notified that GHD/ARTC would be making contact with them to organise an individual meeting.
Agency Consultation	ARTC would make contact with representatives of government agencies at the federal and state levels to introduce the Project and the EA.
Individual Meetings with Residents / Landowners or Other Interested Parties	ARTC would meet with specific individuals identified in cooperation with ARTC as being potentially impacted by the project. It is noted that these individuals would need to be met potentially at each phase, i.e. initial announcement of project, preliminary Environmental Assessment phase, concept design phase, and prior to submission of the EA.

Activity	Purpose
Stage 3 – Exhibition of the EA	
Uploading of information on website and 1800 number	As soon as the EA is announced, ARTC would upload all information, including the EA report, into the project website. ARTC would also upload revised working for the 1800 number and answering service, which would highlight where and for how long the EA will be exhibited.
Community Update No.2	To encourage people to visit the EA exhibition, ARTC would prepare an A4 double sided community update to advise stakeholders of the locations of the displays and encourage feedback.

Appendix A

Concept Design Report

CLIENTS | PEOPLE | PERFORMANCE

Australian Rail Track Corporation

Minimbah Bank Third Track - Concept Design

Volume 1 Concept Design Report

December 2007

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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Executive Summary

Project Background

ARTC commissioned GHD to investigate options for a new third track from Whittingham to Minimbah. This report is the Concept Design Report and has been produced at the end of the Concept Design stage to provide a summary of the project to date for review by ARTC and other stakeholders. The report comprises the following separate volumes:

Volume 1: Concept Design Report;

Volume 2: Appendices to the Concept Design Report; and

Volume 3: Concept Design Drawings.

Selection of a Preferred Option

An earlier options review study by GHD identified eight possible routes for a third track at Minimbah Bank. These options were workshopped with ARTC and the Rail Infrastructure Group (RIG) with 3 preferred options being agreed. Based on the adopted evaluation criteria, workshop results were too close to select a final option with any confidence. GHD undertook additional studies and held further workshops with ARTC to facilitate the selection of a single option. This resulted in the selection of Option 6 as the preferred alignment. Option 6 is a third track for Up trains on an alignment running parallel to the existing Up main at a revised grade of 1:100.

Concept Design

The concept design of Option 6 discussed in this report includes:

- Approximately 10.8km of track alignment design, bulk earthworks and drainage between chainages 224.220km and 235.070km;
- Signalling concept and functional specification;
- Services relocations;
- Treatment of level crossings including:
  - Grade separation of Range Road level crossing (233.958km);
  - Closure of a private level crossing (231.800km) and provision of new private access;
- Bridges including Golden Highway overbridge (228.750km), Range Road overbridge (233.958km), Mudies Creek underbridge (232.220km) and a major culvert at 234.240km; and
- Partial realignments of Range Road and the Golden Highway.

The Option 6 concept design is based on the following configuration.

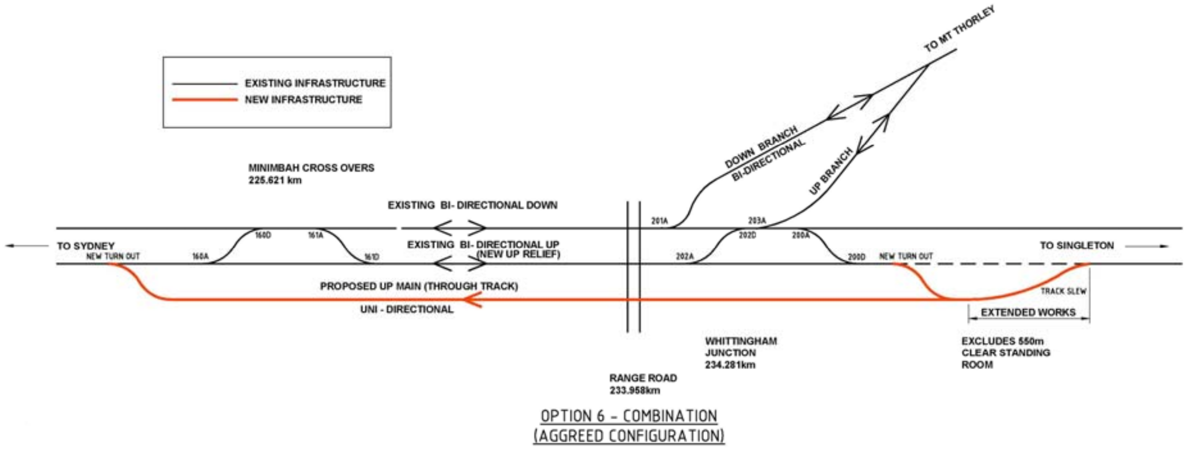

Figure 1 Option 6 Combination Configuration

Part 1: Introduction

1. Introduction

1.1 Project Background

On 5 September 2004, the Australian Rail Track Corporation (ARTC) commenced a 60 year lease of the interstate and Hunter Valley rail lines of New South Wales. Since commencing this lease, the Hunter Valley network aspects have been reviewed and updated by ARTC in light of rapid growth in coal demand. This has resulted in the development of the Hunter Valley Corridor 2007 – 2012 Capacity Strategy Consultation Document (the Strategy).

At present, export coal capacity of the Hunter Valley rail network averages around 107 million tonnes per annum (mtpa). Current industry forecasts indicate demand on the Hunter Valley rail network will increase to 165 mtpa by September 2009. ARTC is therefore implementing a strategy of line improvements endeavouring to keep system capacity ahead of industry demands. Design and construction of the Minimbah Bank Third Track is a key component in meeting the objectives of the Strategy.

1.2 The Problem

Minimbah Bank is 1 of only 3 sections of track on the Main North line with headways in excess of 10 minutes. To cater for the increased line capacity specified in the Strategy, the existing headway of approximately 14 minutes needs to be reduced to 8 minutes in order to achieve the required 165 mtpa coal carrying capacity requirement at Minimbah Bank.

Due to the steep grade of Minimbah Bank (approximately 1:80), loaded coal trains are unable to negotiate the Bank at sufficient speeds creating the current headway of 14 minutes. The steep grade also results in trains stalling on the Bank creating severe service disruptions, increased rail wear and reduced line capacity. As 95% of coal trains in the Hunter Valley negotiate Minimbah Bank, this problem has significant impacts to the current and future line capacity.

The current constraint of the Hunter Valley coal carrying system (from mine to ship) is Port Waratah’s ability to load the quantity of coal transported by rail onto export vessels. By September 2009, the new coal loader at Port Waratah is due to be commissioned, meaning therefore, the constraint on the coal carrying system will become the rail network. Specifically, the delays caused to loaded coal trains by the Minimbah Bank.

ARTC has therefore requested the Minimbah Bank Third Track project be complete by September 2009 in line with the commissioning of the new coal loader at Port Waratah.

1.3 Minimbah Bank Third Track

The Minimbah Bank Third Track, located approximately 10km south of Singleton on the Main North Line, extends from Belford to north of Whittingham Junction. The third track preferred option, known as Option 6, consists of a third track adjacent to the existing Up main line at a revised grade of 1:100 in comparison to the grade of the existing main line of 1:80. The major elements of the third track include approximately 12km of track and earthworks, 3 new rail under bridges, grade separation of Range Road level crossing, replacement and realignment of the Golden Highway overbridge, services relocation, signalling works and property acquisition.

1.4 GHD's Commission

In November 2006, ARTC engaged GHD to progress the Minimbah Bank Third Track project. The purpose of this project is to assist in easing headway and line capacity constraints on the Main North Line.

To facilitate the delivery of this project, GHD agreed with ARTC to divide the project into 4 stages. These stages and the work completed for each stage are discussed in the following sections. Note that the completion of each stage is a formal hold point for the project to allow review of the project by the Rail Infrastructure Group (RIG), which ultimately endorses the funding and direction of the project for the following stage.

1.4.1 Stage 1 – Options Evaluation and Identification of Preferred Options

Stage 1 of the project consisted of identification and evaluation of possible third track options. In total, GHD assessed in detail 8 options, including 4 previously identified by Rail Infrastructure Corporation (RIC). Key tasks completed by GHD during Stage 1 included:

- Identification, development and assessment of 8 potential third track alignments;
- Order of magnitude cost estimate for these 8 options; and
- Selection and agreement with ARTC and project stakeholders of 3 preferred options to progress to concept design (Stage 2).

Stage 1 was successfully completed in May 2007.

1.4.2 Stage 2 – Concept Design of Preferred Options and Selection of a Preferred Option

In July 2007, GHD received approval from ARTC and the RIG to commence the Stage 2 works. This concept design report relates to this stage.

Originally, the primary purpose of Stage 2 was to progress engineering of key elements of the preferred options enabling the refinement of capital cost estimates and selection of a preferred option. In progressing this original scope, a number of issues arose altering the assessment criteria and therefore the delivery method of the project. Specifically, these relate to the refinement of previously agreed junction configurations (and associated operational issues) and the completion date of the project being brought forward from January 2010 to September 2009. The alteration of the assessment criteria enabled the early selection and recommendation of a preferred option.

The preferred option (option 6) was agreed with ARTC resulting in GHD progressing a robust concept design of a single option, as opposed to preliminary concept designs on 3 options.

Stage 2 was successfully completed in December 2007.

1.4.3 Stage 3 – Detailed Design, Tendering and Approvals

Approval to commence Stage 3 has not yet been obtained. Stage 3 is due to commence in January 2008.

1.4.4 Stage 4 – Construction and Commissioning

Approval to commence Stage 4 has not yet been obtained. Stage 4 is due to commence from late 2008; however, work cannot commence until Part 3A approval is received from the NSW Minister of Planning.

1.5 Project Objectives

1.5.1 Core Objectives

- Reduce headway for loaded coal trains to 8 minutes;
- Increase line capacity to 165 mtpa; and
- Have the reduced headway and increased line capacity in place by September 2009.

1.5.2 Non Core Objectives

- Maximise operational benefits beyond the core objectives within the constraints of the operational requirements;
- Minimise impacts to existing operations during construction;
- Minimise impacts to existing operations during maintenance;
- Minimise the quantity of property acquisition and property severance required;
- Minimise capital expenditure;
- Minimise life cycle maintenance costs; and
- Minimise signalling and communications complexity.

1.5.3 Third Track Operational Requirements

In addition to the core objectives of reduced headway and increased line capacity, operational requirements of the Minimbah Bank Third Track are as follows.

- Operational conflicts at Whittingham Junction should be minimised;
- Junction configurations should allow parallel trains to run Up Minimbah Bank;
- Bi-directional running on the existing Up and Down mains, with uni-directional running on the New Up main;
- Minimise or eliminate the risk of trains coming to a stand while scaling the grade;
- Minimbah crossovers to remain;
- Provision for greater recovery flexibility if a train stalls on the grade;
- Permit re-sequencing of coal trains on the grade if required;
- Allow trains moving from a stationary start to travel up the Bank without disrupting 8 minute headways; and
- Junction configurations to allow for parallel trains from Mt Thorley or Singleton to scale the grade simultaneously.

1.6 Existing Situation

1.6.1 General

The existing section of track known as the Minimbah Bank is approximately 8km long and extends from Whittingham Junction at chainage 234.000km to the crest at Minimbah at chainage 226.000km. The Bank contains the ruling grade for the Newcastle to Muswellbrook line. Minimbah Bank has:

- Grades of 1:78 to 1:84 for Up trains (ruling grade of 1:80);
- Tonnage signal at 231.800km;
- Up paths limited to 55, compared to 104 Down paths per day; and
- Headways for Up coal trains of 14 minutes, compared to a design headway of 10 minutes on adjacent sections of track.

1.6.2 Signalling

The current signalling system between Whittingham and Branxton has bi-directional operations on both the Up and Down main lines. The signalling is controlled from the Broadmeadow CTC using a Phoenix control system interfacing to the main interlocking system using a Kingfisher Telemetry Interface at Whittingham, Minimbah and Branxton. Current field equipment is composed of AC/DC track circuits, 3 light single head LED signals and Westinghouse D84M or Nippon 1211B motor points on 1:18.5 tangential turnouts.

1.7 Site Location

The location of Minimbah Bank is illustrated in Figure 2.

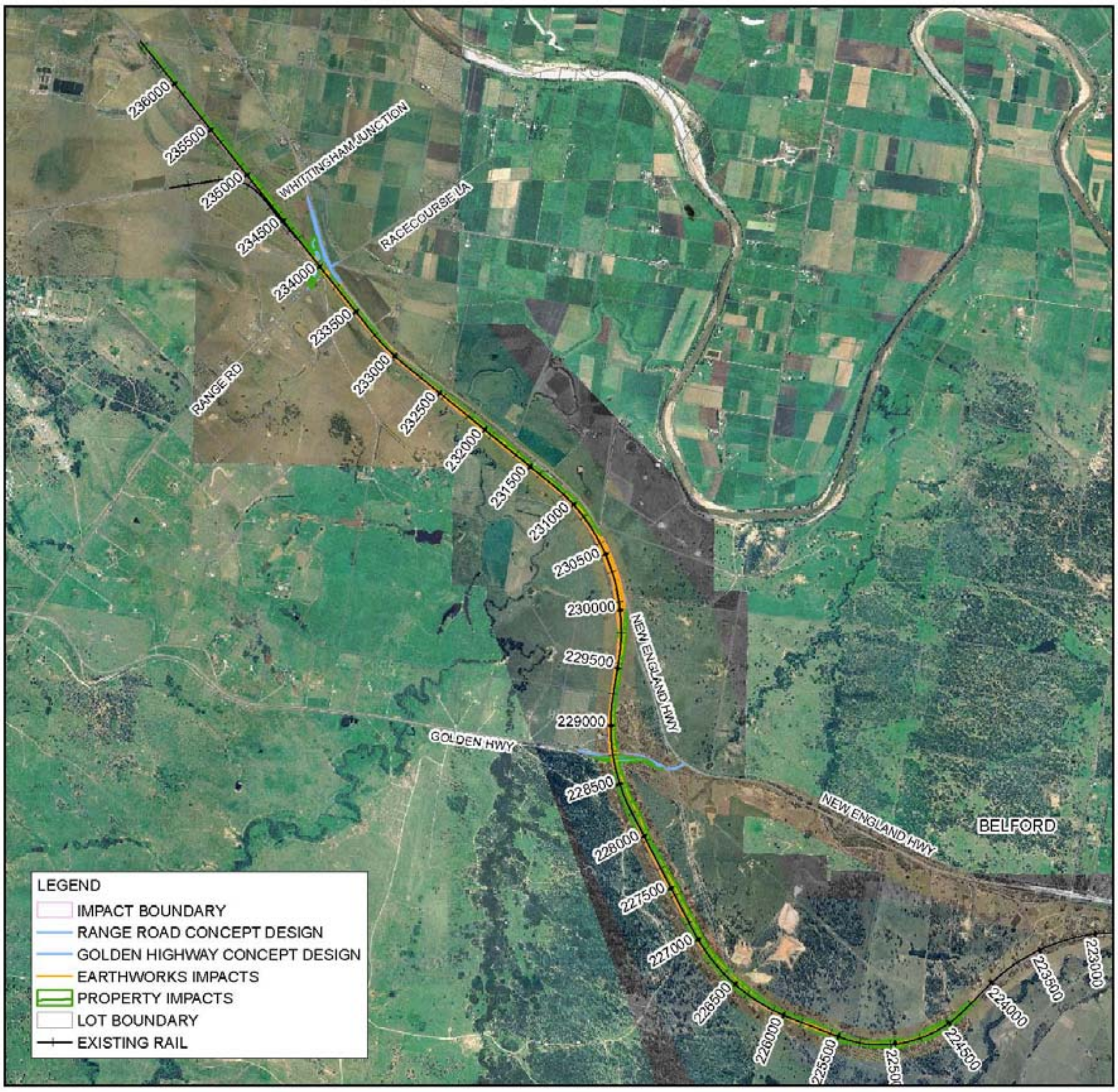

Figure 2 Minimbah Bank

1.8 Third Track (Option 6) Overview

1.8.1 Alignment

Option 6 is a third track that runs adjacent to the Up main of the existing main line at a maximum grade of 1:100. The third track, known as the new Up main, begins at chainage 235.070km and rejoins the main line at chainage 224.220km. The difference in the new Up main and existing main line grades is illustrated in Figure 3 below.

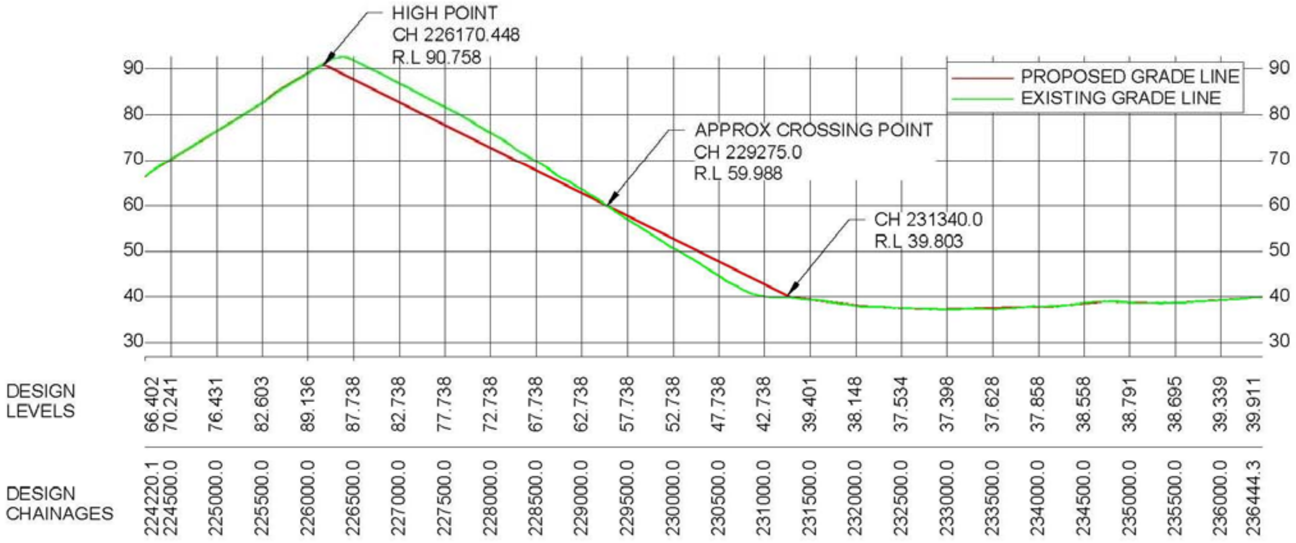

Figure 3 Option 6 Long Section

The new Up main is designed at a minimum of 6.5m track centres to the existing Up main, which increases to a maximum of approximately 18.5m due to batter slope requirements. Between chainages 235.070km and 231.340km the new Up main is at the same grade as existing. At chainage 231.340km the 1:100 grade commences with the New Up main rising higher than the existing main line, resulting in the new Up main being on a significant fill batter at a maximum height of 3.5m above the existing main line.

At approximate chainage 229.275km the new Up main and existing main line grades meet at a common level of 1:80. At this location, the new Up main then drops lower than the main line, resulting in the new Up main being in a significant cut at a maximum depth of 4.25m below the existing main line.

By approximate chainage 226.170km the grades of the new Up main and existing main line are again level with the new Up main re-joining the main line at chainage 224.221km.

1.8.2 Major Infrastructure Elements

Major infrastructure elements included in the concept design are as follows:

- Approximately 10.8km of track including turnouts, junctions and signalling;
- Approximately 10.8km of earthworks including drainage and minor structures;
- Rail under bridge (major culvert) at chainage 236.472km;
- Mudies Creek rail under bridge at chainage 232.167km;
- Golden Highway over bridge and associated road works at chainage 228.790km;
- Grade separation of Range Road level crossing at chainage 233.958km;
- Proposed closure of a private level crossing at chainage 231.180km with provision for alternate private access;

- Retaining wall approximately 3 m high x 465 m long between chainages 230.215km and 230.675km to retain the third track fill batter from encroaching on the New England Highway road reserve; and
- Approximately 10.8km of services relocations including gas, optic fibre, power (above and below ground), telephone and water.

1.9 Concept Design Format

The concept design consists of the following separate volumes.

Volume 1 – Concept Design Report

This report includes a detailed discussion on the concept design including elements such as scope, design development, design methodology and project risks/issues. This report is divided into the following parts.

- Part 1 – Introduction (including design development and selection of a preferred option);
- Part 2 – Rail, Bulk Earthworks and Drainage (including signalling);
- Part 3 – Level Crossings;
- Part 4 – Bridges; and
- Part 5 – Cost and Program.

Volume 2 – Appendices to Concept Design Report

Includes the appendices to Volume 1, which are relevant documents referenced in the Concept Design Report.

Volume 3 – Concept Design Drawings

Includes a suite of engineering concept drawings for major elements of the project.

1.10 Cost and Program

Program and capital cost estimates are discussed in detail in a separate report titles “Minimbah Bank Third Track Concept Design – Cost and Program”.

2. Selection of a Preferred Option

2.1 General

Upon commencement of the original Stage 2 scope of works, 3 preferred options were being progressed. In order to differentiate these options a number of factors were analysed in detail. These analyses all assisted in the selection of a final option. These included:

- Life cycle maintenance costs of the 3 options;
- Property acquisition issues;
- Flora and fauna constraints assessment of the impacted area of the 3 options; and
- Operational requirements.

Upon commencement of the Stage 2 works, GHD were informed by ARTC of the proposed completion date of the project being brought forward from January 2010 to September 2009. This reduction in program greatly influenced the early selection of a preferred option.

2.2 Preferred Options

The 3 preferred options considered in the progression of the Stage 2 works are as follows.

Option 1 – A third track for Up trains on an alignment running parallel to the New England Highway at a revised grade of 1:100;

Option 6 – A third track for Up trains on an alignment running directly parallel to the existing Up main at a revised grade of 1:100; and

Option 7 – A third track for predominately Down trains on an alignment running directly parallel to the existing Down main at the existing grade.

The preferred options are illustrated in Figure 4 below. For a detailed discussion on these options, refer to the Preferred Options Report in Appendix N.

Since completing the Preferred Options Report, the length and therefore scope of the third track has increased. At the instruction of ARTC, the third track has been extended by approximately 1.8km north of Whittingham Junction from 234.220km to 236.454km. This resulted in increased impacts to existing infrastructure, additional capital costs and property acquisition. Due to this increase in scope the information detailed in the Preferred Options Report is not current and is therefore to be used for comparison purposes of the 3 preferred options only.

Note that the following discussions on maintenance regimes, property acquisition and environmental assessments were completed prior to the instruction to extend the track north of Whittingham Junction. These assessments have therefore only taken into account the original length of track commencing from chainage 234.220km.

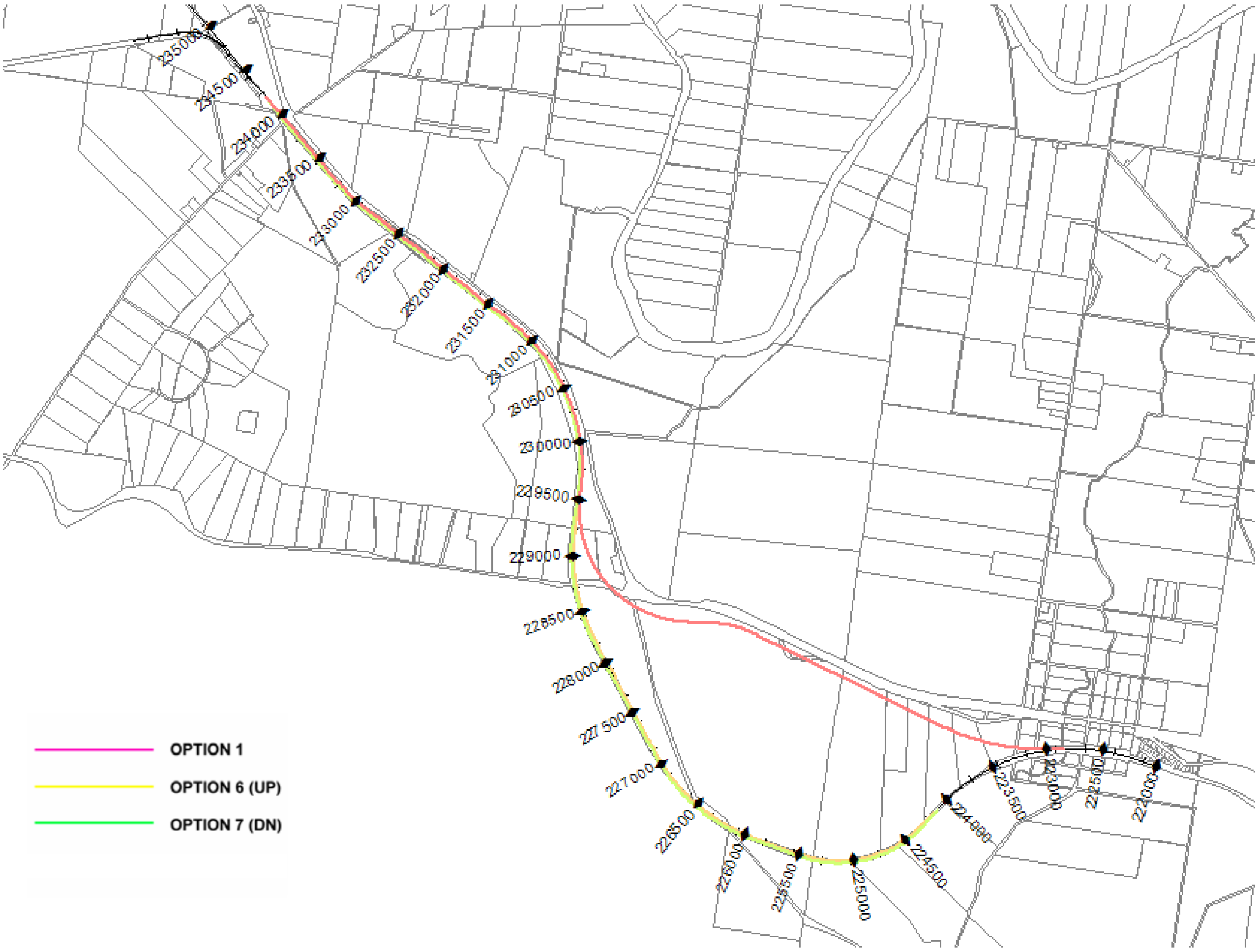

Figure 4 Minimbah Bank Third Track Preferred Options

2.3 Program

When commencing work on the Minimbah Bank Third Track project in November 2006, ARTC's Strategy required the construction and commissioning of the project to be complete by January 2010. In September 2007, ARTC moved the proposed completion date of this project forward to September 2009 in order to have the third track commissioned in line with the completion of Port Waratah's new coal loader. This reduction in program has emphasised a number of issues that are likely to be critical to the completion of the project by this date, such as approvals and property acquisition. The reduction in program also highlighted the need to accelerate the selection of a preferred option.

At the commencement of Stage 2, 3 preferred options had been short-listed and were to be progressed in order to refine capital cost estimates. The reduction in program altered this approach by highlighting the need to select a final option as soon as possible. In light of the reduced program, selection criteria and associated weightings used to assess options during Stage 1 were appropriately altered in consultation with ARTC. The criteria and weightings were changed to emphasise program issues that assisted in the early selection of a preferred option.

Option selection criteria and associated weightings are discussed in Section 2.9 of this report.

2.4 Environmental Assessment and Approvals

At the request of ARTC and project stakeholders, GHD completed a preliminary assessment of the likely environmental assessments and approvals process required for each of the preferred options.

This preliminary assessment was requested; as there was a perceived risk that Option 1 may be subject to more stringent environment approvals. This was due to the majority of the Option 1 alignment being separate from the existing main line in a new corridor. Initial assumptions were that having a new corridor separate from the existing main line and close to existing residence, might impose stricter operational conditions due to issues such as noise and air quality.

The preliminary assessment concluded that the environmental assessments and approvals are the same for each option with conditions constraining operations being unlikely. It is possible that Option 1 may require more rigorous control measures given its proximity to residences, however this cannot be determined until detailed investigations are undertaken.

In each case, the environmental assessment to be undertaken under Part 3A of the EP&A Act is likely to be similar. The Environmental Assessments and Approvals report is included in Appendix C.

2.5 Maintenance Review

To assist in the comparison of the preferred options, a maintenance review was completed to compare the costs and track possessions required to maintain the track over the life of the asset. The review focused on a 30 year maintenance period in order to include the predicted real costs of major upgrade works required through this period. The complete maintenance regime report is detailed in Appendix M.

The maintenance regime report included an analysis of the existing Up main, existing Down main and proposed New Up main for each preferred option for a total line capacity of 165 mtpa. The maintenance regime considered each option in isolation between chainages 222.860km and 234.220km. The 3 maintenance criteria included in this review are:

- Routine Maintenance;
- Cyclic Major Periodic Maintenance; and
- Strategic Major Periodic Maintenance.

The results from the maintenance review are summarised in Table 2-1 below.

Table 2-1 Maintenance Review Results

Option	Total Maintenance Cost ($) 30 Year Period	Total Possession Time (hours) 30 year Period
1	$52,829,208	11,464
6	$54,015,979	11,580
7	$69,441,891	13,144

Results for the maintenance review clearly indicate Option 1 is the least expensive from both a cost and possession perspective over the 30 year period. Option 7 stands out as the most expensive to maintain as well as having the most significant impact on possession requirements. Option 6 is slightly more expensive than Option 1, and has a slightly higher requirement for maintenance possessions where operational traffic would need to be stopped from running. The cumulative difference between Options 1 and 6 appears to be negligible.

With Option 7, the present Down Main would become a second Up main. For this maintenance review, it has been assumed the two Up mains would each carry 50% of the predicted line capacity of 165 mtpa with empty coal trains utilising the new Down main. This configuration results in Option 7 being the most expensive to maintain as:

- There would be need to replace rail on the existing down main as increased wear will result from the increased line capacity on the old infrastructure;
- There would be an expected increase in formation repairs required on the present Down Main due to increased tonnage issues being constrained by the new Down Main and the present Up Main;
- Increased grinding and resurfacing costs for the present Down Main; and
- Additional cyclic ballast cleaning required.

For Options 1 and 6, it was assumed during the maintenance review that the new third track would be used as an Up Main and take 50% of the increased capacity. As this infrastructure will be new, the maintenance costs are reduced.

2.6 Property Acquisition Issues

Property acquisition is seen as a major risk to the program of the Minimbah Bank Third Track project. During Stage 1, indicative property acquisition quantities and issues were identified for comparison purposes to assist with the selection of a preferred option. Since this time, ARTC brought the completion date for the program forward from January 2010 to September 2009. This reduction in program further highlighted the risks to program associated with property acquisition, and prompted a risk assessment to be conducted on property acquisition issues only. This risk assessment was conducted in October 2007 with GHD and ARTC. The Property Acquisition Risk Assessment report is included in Appendix L.

For each of the preferred options, the risk assessment was used to:

- Clarify and confirm a holistic understanding and awareness of the issues associated with the property acquisition aspect of the project;
- Determine if there is an actual or perceived property acquisition risk for each of the preferred options; and
- Identify a preferred option with regards to property acquisition through utilising risk based analysis and comparison.

The indicative impacts determined during the Stage 1 works that were used as the basis for this risk assessment are as follows.

Table 2-2 Summary of Property Acquisition Impacts

	Option 1	Option 6	Option 7
Total area of acquisition required	28.1 hectares	12.7 hectares	4.4 hectares
Total number of properties affected	24	16	14
Estimated number of properties severed by the third track	9	0	0

The results from the risk analysis indicate that there is an actual property acquisition risk with all options, however Option 1 clearly poses the most risk towards the delivery of the project. The differences in the level of risk between Option 1 and Options 6 and 7 are substantial, however the difference in risks between Options 6 and 7 is less significant. This is predominately due to options 6 and 7 requiring widening of the existing corridor only, whereas option 1 requires a new corridor altogether, resulting in large quantities of property severance.

The results in this process indicate that Option 7 poses the least risk to the project in terms of property acquisition. These results led to the following key recommendations:

- On the basis of property acquisition risk and associated impacts to the September 2009 delivery date, Option 1 should be removed from further consideration as the preferred option; and
- If project criteria other than property acquisition, such as operations, maintenance costs, constructability and impacts to existing operations, cannot differentiate between options 6 and 7 a more detailed property acquisition risk assessment should be completed for Option 6 and 7 only.

2.7 Flora and Fauna Constraints Assessment

As an extension of the preliminary assessment of the required environmental assessments and approvals process, an ecology assessment of the impacted areas for the preferred options was completed. The assessment focused primarily on flora and fauna impacted by the preferred options and the associated ecological constraints that are likely to be encountered in the detailed environmental assessment. The purpose of this assessment was to identify flora and/or fauna within the impacted area that may hinder the progression of the project (eg endangered species etc) as well as to assist in the selection of a preferred option.

The assessment consisted of the following stages:

- A review of available literature pertaining to the site and surrounding localities including a preliminary habitat assessment of the site;
- Completion of targeted field surveys for threatened species regarded as potential subject species, and surveys to investigate the inherent biological attributes of the site; and
- Impact assessments of the third track(s) on flora and fauna in accordance with the relevant NSW and Commonwealth legislation and planning instruments.

The ecology assessment, completed by Ecotone Ecological Consultants, is included in Appendix J. The ecological impacts reported during this process for the preferred options are summarised as follows.

2.7.1 Option 1

Option 1 is considered more likely to have high ecological impacts in comparison to Options 6 and 7. This conclusion is based primarily on the greater extent of native vegetation likely to require removal and the potential for increased fragmentation of bushland north of the New England Highway.

2.7.2 Option 6

Option 6 is considered to have the lowest ecological impacts in comparison to Options 1 and 7. This conclusion is based primarily on the lesser extent of native vegetation likely to require removal. While Option 6 is likely to result in the widening of the current gap between patches of vegetation across the rail corridor, no additional bushland areas are likely to become fragmented or isolated as a result of this option.

2.7.3 Option 7

Option 7 is considered to have a relatively low to moderate ecological impact, less than that for Option 1 but greater than that for Option 6. This option is likely to require the removal of more vegetation than Option 6, as widening the existing corridor on the Down side may result in the loss of a long strip of vegetation south of the Golden Highway. However, unlike Option 1, this option is unlikely to result in additional bushland areas becoming fragmented or isolated.

2.7.4 Ecology Assessment Conclusion

In conclusion, Option 1 is likely to have the greatest impact to the local ecology. Options 6 and 7 would both have lower impacts than Option 1, with Option 7 having a higher impact than Option 6.

2.8 Junction Configurations

In March 2007, GHD facilitated a workshop with ARTC operations staff to agree upon the required junction configurations for the preferred third track options. The agreed configurations were known as “Fully Flexible” configurations. The Fully Flexible configuration consist of multiple turnouts and multiple levels of redundancy at both Whittingham Junction and Belford. Since this date, ARTC have reviewed the need for Fully Flexible junction configurations with a view to reducing capital and ongoing maintenance costs. This has resulted in the junction configurations for the third track being refined to a Base Case junction configuration scenario with reduced functionality. Justification for this includes:

- Operational objectives can be achieved with a less complicated and less functional configuration;
- Multiple levels of redundancy in the fully flexible configuration would be used infrequently;
- Commissioning and maintenance of the fully flexible configuration will adversely impact existing operations on the main line, negating any additional capacity benefits obtained from the added functionality; and
- A Base Case configuration will cater for the predicted future capacity of the Mt Thorley line.

Two Base Case junction configurations have been developed for the preferred third track alignments. These are illustrated in Figure 5 and Figure 6 below. The first configuration is applicable to third track options 1 and 6 (alignments on the Up side of the existing main line) and the second being for option 7 (an alignment on the Down side of the existing main line).

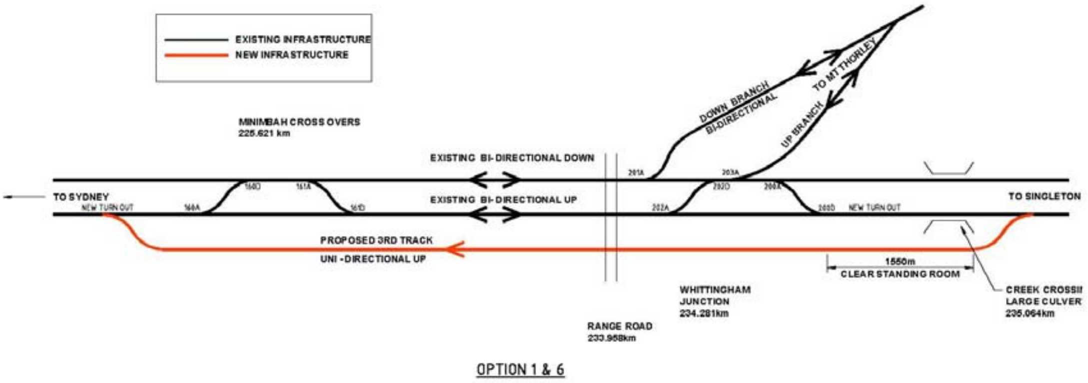

Figure 5 **Option 1 and 6 Base Case Junction Configuration**

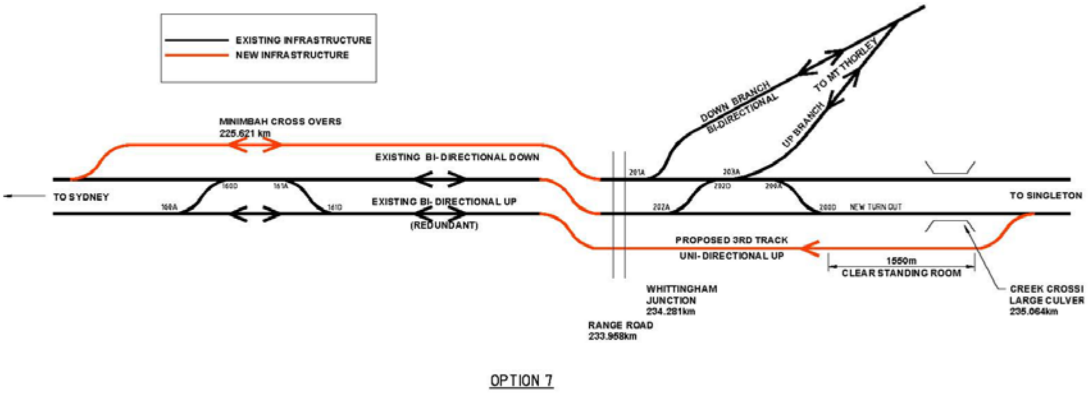

Figure 6 **Option 7 Base Case Junction Configuration**

With regards to operational issues, it was agreed by ARTC operations staff that the Base Case junction configuration for options 1 and 6 was preferable to option 7 as a Down main third track presents a number of negative impacts not applicable with an Up main third track. These negative impacts include:

- Minimbah crossovers would become redundant;
- Increased impact on operations during construction due to the track slews required;
- Requires bi-directional signalling on the new track; and
- Makes bi-directional signalling on the existing up main redundant.

These and other operational issues are discussed in more detail in the Junction Configurations, Operational Issues and Criteria Analysis Document, dated October 2007, which is included in Appendix H.

2.9 Selection of a Preferred Option

2.9.1 Assessment Summary

Table 2-3 summaries the outcomes of the assessments completed on the preferred options during Stage 2.

Table 2-3 Preferred Option Assessment Summary

	Option 1	Option 6	Option 7
Maintenance impacts (over a 30 year period)	Low $52.8 million 11,464 possession hours	Low $54.1 million 11,580 possession hours	High $69.4 million 13,144 possession hours
Property acquisition risks and impacts to program	High	Medium	Low
Environmental assessment and approval constraints	Nil (all options equivalent)	Nil (all options equivalent)	Nil (all options equivalent)
Impacts to local ecology	High	Low	Medium
Level of operational issues (based on “Base Case” Junction Configuration)	Low	Low	High

2.9.2 Selection Criteria and Weightings

In May 2007, GHD facilitated a preferred options workshop with ARTC and project stakeholders. A key outcome of this workshop was the definition of assessment criteria and associated weightings.

Since this workshop, criteria and associated weightings have altered due to changes in strategies by ARTC and progression of engineering aspects by GHD. The key changes since this workshop is the required completion date of the project. As discussed in Section 2.3, January 2010 was the original completion date of the Minimbah Bank Third Track, however, this has recently been brought forward to September 2009. This reduction in program highlighted the urgent need to select a preferred option to enable critical long lead tasks to begin as soon as possible.

In light of the revised program dates and other mitigating factors (such as operations), GHD in consultation with ARTC refined the previously agreed assessment criteria and associated weightings. The revised assessment criteria and weightings were now weighted more heavily towards program issues due to the completion date for the project being brought forward to September 2009. This enabled the selection and recommendation of a preferred option to ARTC and the RIG. The revised criteria and associated weightings used in the selection of a preferred option are detailed in Table 2-4.

Table 2-4 Selection Criteria and Weightings

Criteria	Weighting
Operational benefits beyond the core objectives	5%
Property acquisition risks and issues	10%
Impact on existing operations during construction	15%
Impact on existing operations during maintenance	10%
Environmental issues (impact to the environment)	5%
Reliability in delivery by September 2009 (approvals)	17.5%
Reliability in delivery by September 2009 (construction)	17.5%
Capital expenditure	5%
Life cycle - maintenance	10%
Complexity of signalling and communications	5%

2.9.3 Options Analysis and Discussion

For a detailed discussion and analysis on comparisons of the options based on the aforementioned selection criteria and weightings, refer to the Operational Issues and Criteria Analysis Document, dated October 2007, included in Appendix H.

The results of this analysis indicated the preferred option is Option 6. The result of this analysis is as follows. Note that the higher the score, the better the result.

Table 2-5 Results of Options Analysis

Option 1	Option 6	Option 7
4.15	6.36	5.47

On the basis of this analysis, Option 6 was recommended as the preferred option to ARTC and the RIG. Option 6 was subsequently accepted as the preferred option enabling GHD to progress the concept design of this option only.

The remainder of this report discusses the concept design of Option 6 and associated design outputs.

3. Design Development

3.1 Design Criteria

In progressing the concept design of the preferred option, the design criteria for the design of the third track were developed in consultation with ARTC and formally documented in the project's Design Criteria Report.

Forming the foundation of the design, the design criteria details applicable ARTC and Australian standards as well as applicable reference documents that have been used in the development of the third track. Other determining factors, such as departure from ARTC standards are also clearly listed in the Design Criteria Report.

The Design Criteria Report is included in Appendix B.

3.2 Environmental Issues

Apart from the ecology assessment of the preferred options (refer to Section 2.7) environmental issues applicable to the Minimbah Bank Third Track project have not been progressed as part of this commission. Environmental issues, such as heritage (indigenous and non-indigenous), noise, air quality, detailed hydrology studies, social and economic impacts will be undertaken as a separate commission.

Addressing and managing the environmental issues for this project is included in the Environmental Assessment process.

3.3 Survey

GHD's concept design is based predominately on aerial survey provided by ARTC sub consultant Fugro Spatial Solutions.

Detailed ground survey is preferred for this design, however this could not be obtained at this stage of the project. Due to the current confidentiality of the Minimbah Bank Third Track, ARTC did not wish to exercise its Rights of Entry (under the Transport Administration Act 1988) to obtain access to private property, as this would involve formal notification and community consultation with the affected residents. ARTC does not wish to make this project public and commence the community consultation process until the formal agreement of the concept design has been advised by ARTC's board. At the time of writing this report, this has yet to be achieved.

The accuracy of aerial survey received from Fugro Spatial Solutions is approximately +/- 200mm (horizontal and vertical), therefore the detail of GHD's concept design is commensurate with this accuracy. In addition to the aerial survey, areas where additional detailed survey was obtained are as follows:

- As per GHD's original scope, aerial survey was only obtained up to chainage 235.500km. After completion of the aerial survey, ARTC instructed the third track be extended approximately 1.8km north of Whittingham Junction, meaning the aerial survey obtained did not cover the extended area. To cater for this short fall in survey data, detailed ground and track survey was undertaken for the affected area between 235.500km and 237.000km. Accuracy of survey received in this location is approximately +/- 100mm; and

- Track features for the intersection/interface of the proposed third track with the existing Main North track to an accuracy of approximately +/-10mm.

3.4 Geotechnical Review

For the same reasons for not obtaining detailed ground survey, detailed geotechnical investigation was also excluded from this commission. Our commission, however, did include a desktop review of existing geotechnical information provided by ARTC which enabled assumptions to be made in the concept design.

Geotechnical assumptions will be verified and altered as required upon receipt of the detailed geotechnical investigation information in Stage 3.

GHD's geotechnical desktop review is detailed in Appendix G.

3.5 Property Acquisition

Property acquisition requirements for this project have been determined by inputting the impacted area from the concept design into the project's GIS model. This has enabled the calculation of an indicative area of property acquisition required. For a detailed list of properties impacted by the third track, including the estimated area of property acquisition required, refer to Appendix C.

The total area of property acquisition required for this project is currently estimated at approximately **31.6 hectares**, impacting a total of **32** individual properties. Note that this area is based on the footprint of the proposed New Up main and associated infrastructure only and excludes any additional acquisition that may be negotiated by individual property owners. It is noted this quantity of property acquisition is substantially greater than the original estimates made during Stage 1 of 12.7 hectares. This is due to the following reasons.

- The length of track, and therefore property acquisition required has increased by approximately 2 km north of Whittingham Junction;
- Property acquisition associated with Range Road grade separation and Golden Highway road realignment were excluded from the previous estimate;
- Confirmation of earthworks batter design has confirmed the footprint of the project is greater than originally estimated in Stage 1 resulting in an increase in property acquisition; and
- Due to the inaccurate nature of the cadastral information supplied by ARTC (via Land Titles Information), the total footprint of the project has been increased by 10m on either side of the rail corridor to cater for the inaccurate boundary information. This has also resulted in an increase in property acquisition.

Costs associated with the Stage 2 property acquisition quantities have been extrapolated from figures provided by State Property during the Stage 1 works.

3.6 Whittingham Junction Flyover

At the request of ARTC and the RIG, concepts of a flyover at Whittingham Junction have been excluded from this commission. A discussion paper on a potential flyover option and reasons for its exclusion is detailed in Appendix I.

Note that any future requirement for a Whittingham Junction Flyover has been complicated by the Grade Separation of Range Road level crossing. The proposed Range Road grade separation is in a similar location to the Whittingham Junction Flyover option(s). Therefore, a future flyover at Whittingham Junction will be highly constrained which will ultimately impact on issues such as capital cost and property acquisition.

3.7 Project Stakeholders

Project stakeholders are critical to the success of this project. Without the input and endorsement from primary project stakeholders, the Minimbah Bank Third Track project is unlikely to succeed. GHD and ARTC have been continually liaising with applicable stakeholders to assist in the progression of this project. This includes:

- Keeping the Rail Infrastructure Group (RIG) informed of project developments. To formally proceed with each stage of the project, the RIG must formally endorse the project and likely expenditure;
- Liaison with the Signalling Alliance Group to assist in developing the signalling design and allocating appropriate future resources to complete the signalling works;
- Keeping the RTA informed of impacts to the surrounding road infrastructure. Without input and approval from the RTA, significant delays may occur to areas such as the Golden Highway overbridge; and
- Keeping utilities informed whose infrastructure is directly impacted by this project. Relocation of services prior to construction commencing is likely to be a critical task; therefore, input from the applicable utility companies is required.

3.7.1 Primary Stakeholders

Primary stakeholders for this project are those persons and groups that have a legal relationship to the project. Such stakeholders include the project owner, functional groups, investors, groups from the public domain and infrastructure providers whose laws and regulations must be obeyed.

The primary stakeholders for this project are as follows:

- Australian Rail Track Corporation (ARTC);
- Rail Infrastructure Group (RIG) consisting of:
  - Pacific National; and
  - Queensland Rail.
- Signalling Alliance Group;
- Roads and Traffic Authority (RTA);

- Public utilities including:
  - AGL;
  - Energy Australia;
  - Singleton Council (water and sewer); and
  - Telstra.

3.7.2 Secondary Stakeholders

Secondary stakeholders for this project are defined as those who influence or affect, or are influenced or affected by, the project but are not regularly engaged with the project. Secondary stakeholders may not be essential to the project's survival, however they have the capacity to mobilise public opinion in favour of or in opposition to the project.

The secondary stakeholders to be managed as part of this project are as follows:

- Private land owners;
- Government land owners consisting of:
  - Department of Defence;
  - RTA; and
  - Singleton Council.
- Media; and
- Rail Infrastructure Corporation.

Part 2: Rail, Bulk Earthworks and Drainage

4. Track Alignment

4.1 Design Scope and Overview

4.1.1 Design Scope

The scope of work for track design is to prepare a conceptual engineering design of horizontal and vertical alignments for the proposed third track to applicable ARTC Design Standards.

4.1.2 Overview

The proposed New Up main follows the alignment of the existing Up Main for approximately 10.8km, from chainage 224.220km to 235.070km.

The New Up main is designed to increase the capacity of heavy haul coal trains over Minimbah Bank. This is by duplicating the existing Up main and reducing the grade of the duplicated track. This is to achieve a higher speed for coal trains over Minimbah Bank. To achieve the reduced grade, the New Up main will be in both cut and fill. In areas of cut and fill the distance to the main line is increased to accommodate the required cut/fill batters. This will have benefits during construction as work can be kept at a safer distance from operational traffic.

4.2 Design Methodology

Inrail computer software was used to create a 3D model utilising the aerial survey data and existing track information supplied by ARTC. This model was used to develop the horizontal and vertical alignments that were exported to MX for incorporation with the design for drainage and earthwork etc.

The survey information used for the design is predominately aerial survey with localised areas of detailed track survey. The coordinate system for the survey is based on is ISG 56/1. The MX model enabled the preparation of long and cross sections. AutoCad was used to create track drawings.

The track was designed to achieve the parameters agreed in the Design Criteria Report. The track design has been optimised to balance the cut and fill earth volumes for the whole project including grade separations, bridges and access tracks, as well as minimise impacts to adjacent structures such as the Minimbah Relay Room.

4.3 Design Parameters

The design criteria and standards are presented the Design Criteria Report, included in Appendix B. The key parameters and constraints included in the Design Criteria Report are as follows.

4.3.1 Minimum Track Centres

The New Up main is at a minimum offset of 6.5m to the existing Up main, which increases to a maximum of 18.5m to cater for required earthworks batters in cut and fill areas. This has been utilised in the design to allow signals between the existing Up main and new Up main where the tracks are on a similar level. Where a grade separation of these tracks is required, the track centres were calculated as 8.5m plus 2 times the height difference between the tracks in order to make room for a full shoulder width of 4.25m.

4.3.2 Batter Slopes

The batter slopes adopted for earthworks is 2:1, which directly impacts on track centres. This is subject to geotechnical confirmation, which may flatten or steepen the batters.

4.3.3 Turnout Type

A tangential type of 1:18 Vossloh Cogifer turnout with a radius of 1,200m has been used allowing a maximum turnout speed of 80km/h. The turnouts are standard tangential located on a straight track.

4.3.4 Retaining Wall

In developing the track alignment, the aim has been to minimise the use of retaining walls between tracks, adjacent to the New England Highway and at other highly constrained areas.

4.3.5 Clearances

Clearances to existing infrastructure constrained the development of the New Up main alignment. Key infrastructure constraining the track alignment is.

- Minimbah Relay Room (chainage 225.980km);
- Property boundary of the Nursery (chainage 231.500km); and
- Mudies Creek bridge, requiring the track centres for the New Up main to be increased to 8.7m to allow for the construction of the new bridge adjacent to the existing without interfering with existing train operations.

4.4 Options Considered in Design Development

Different variations of the Option 6 alignment considered in an attempt to minimise construction costs, impacts on existing infrastructure and property acquisition are as follows.

4.4.1 Original Option 6 Configuration

This option was the original Option 6 configuration agreed during Stage 1. It consists of a turnout located at Whittingham Junction (chainage 232.500km) with crossovers between the existing Up Main and proposed Up Relief to allow trains coming from Mt Thorley to use the Up relief main. This configuration is illustrated in Figure 7 below.

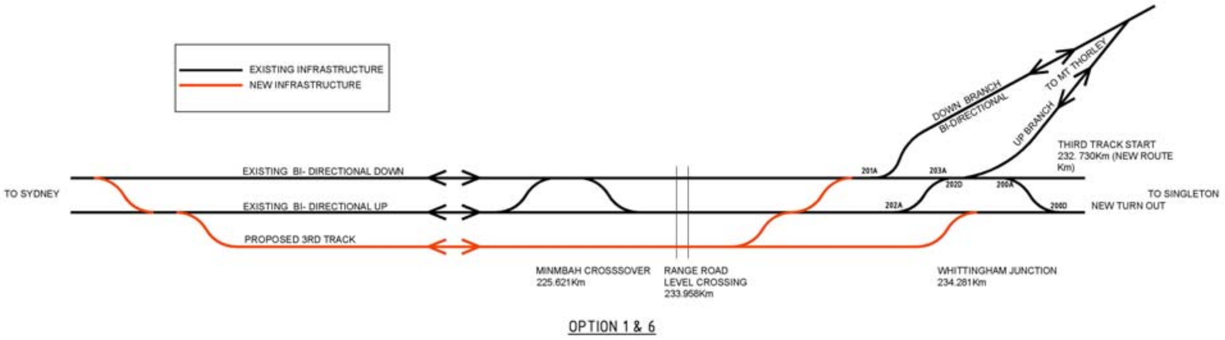

Figure 7 Original Option 6 Configuration

During the design development, ARTC considered this option was too complicated with regards to the operational configuration and maintenance requirements. It was also agreed the multiple levels of redundancy of this configuration would be infrequently used. At the instruction of ARTC, this option was not pursued further. A simpler configuration was agreed, discussed in Section 4.4.2.

4.4.2 Extension of Track North of Whittingham Junction

Upon reducing the Up relief configuration at Whittingham Junction, ARTC instructed the new track to be extended north of Whittingham Junction with simpler junction configurations. This is illustrated in Figure 8 below. This is to enable a train of 91 x 120 tonne wagons worked with 3 x 90 class locomotives with a total length of 1,540m to be able to stop on the Up main at the stop signal at chainage 234.755km. The Up relief was therefore extended to chainage 236.444km to clear a stopped train of 1,540m in length on the Up main with the reduced junction functionality.

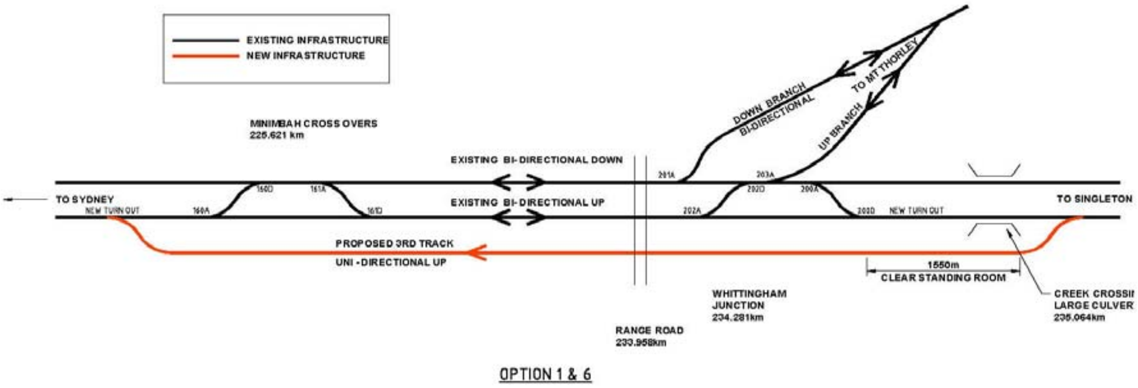

Figure 8 Revised Up Relief Configuration

4.4.3 Through Track Option

The through track option considered in design development consists of realigning the connection points of the proposed Up relief to allow the existing Up main to become the Up relief, the new third track to become a new Up through track. This option is illustrated in Figure 9 below:

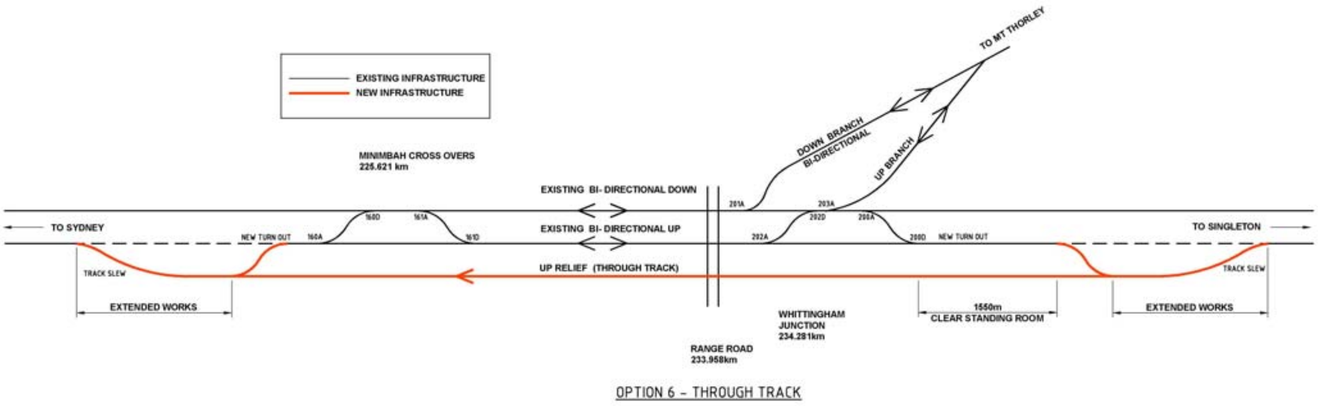

Figure 9 Through Track Option

Relative to the final concept of Option 6, the extent of works for this option is increased at each end of the project to allow for track slews and junction configurations. This extension of works would have major cost and program implications. The infrastructure affected by the extension of work would have included:

- Additional track, earthworks and drainage, due to the extended length of transition required at each end;
- Additional services location and signalling works;
- Extension of a third major culvert, approximately 100m in length at Doughboy Hollow;
- Additional ground survey, services verification and geotechnical investigation; and
- Increase impact on rail operations during construction;

There is also a possibility the required track slews at the Newcastle end may not fit on the existing straight section of track at chainage 224km. If this were the case, the Up relief (through track) would need to be extended a further 2km to re-join the main line.

The option was not progressed for these reasons.

4.4.4 Combination of Through Track and Up Relief Option

The final option considered for the third track was a combination of the Base Case junction configuration and the Through Track option. Originally, ARTC instructed GHD to proceed with the Base Case configuration option including the extension of track north of Whittingham Junction (Figure 7). GHD therefore based the concept design of the third track on this option.

At the presentation of the concept design to ARTC on the 19 December 2007, ARTC instructed GHD to alter this final configuration. The change in configuration included the following alterations.

- Removing the requirement for the 1,550m clear standing room north of Whittingham Junction on the Up Relief, moving the junction configuration back to Whittingham Junction; and
- Amending the junction configuration at the Singleton (northern) end of the track to allow the new third track to become the new Up main (through track) and the existing Up main to become the Up relief (Figure 8).

This was due to ARTC operations not requiring the flexibility to stop trains north of Whittingham Junction, as well as the added maintainability of the through track junction configuration.

At the instruction of ARTC, this revised configuration has been adopted as the final configuration for the Minimbah Bank Third Track. The final configuration is illustrated in Figure 10 below.

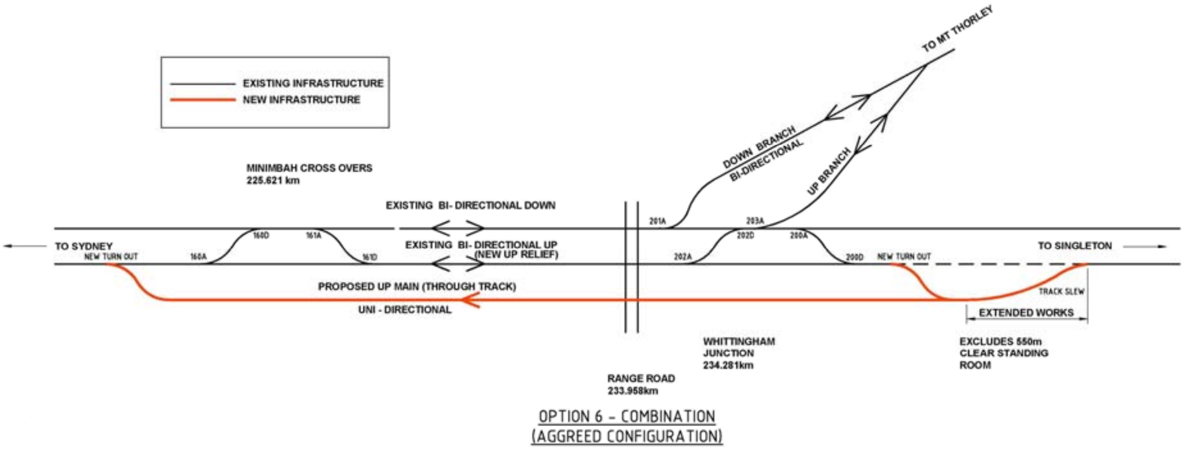

Figure 10 Combination Configuration (Agreed Configuration)

4.4.5 Optimising Cut and Fill

To assist in optimising cut and fill, consideration was given to lowering and raising the 1:100 grade. Several iterations of the track alignment were considered in the design development taking into account grades and vertical curves, particularly around key site constraints such as bridge structures and adjacent private property. The result of these iterations was the balancing of cut and fill across the project, including an acceptable quantity of surplus fill.

Further discussions of cut and fill requirements are included in Section 6 of this report.

4.4.6 Optimising Superelevation for Heavy Haul Coal Trains

Different variations for the applied superelevation have been considered in order to suit different train speeds. Train speeds considered were:

- XPT trains - 160km/h;
- Passengers trains - 115km/h; and
- Heavy haul coal trains - 80km/h.

Two sub-options have been considered by variation of the superelevation:

- To suit the maximum speed for XPT trains with negative deficiency for the slower freight trains; and
- To suit 80km/h heavy haul trains with positive deficiency.

The option with superelevation to suit the heavy haul trains has been adopted and is detailed in Section 4.5.

4.4.7 Track Slews

GHD has investigated a track slew option between chainage 229.700km and 231.200km. This was in an attempt to mitigate the need of a retaining wall at the boundary of the New England Highway. This option is illustrated in Figure 11.

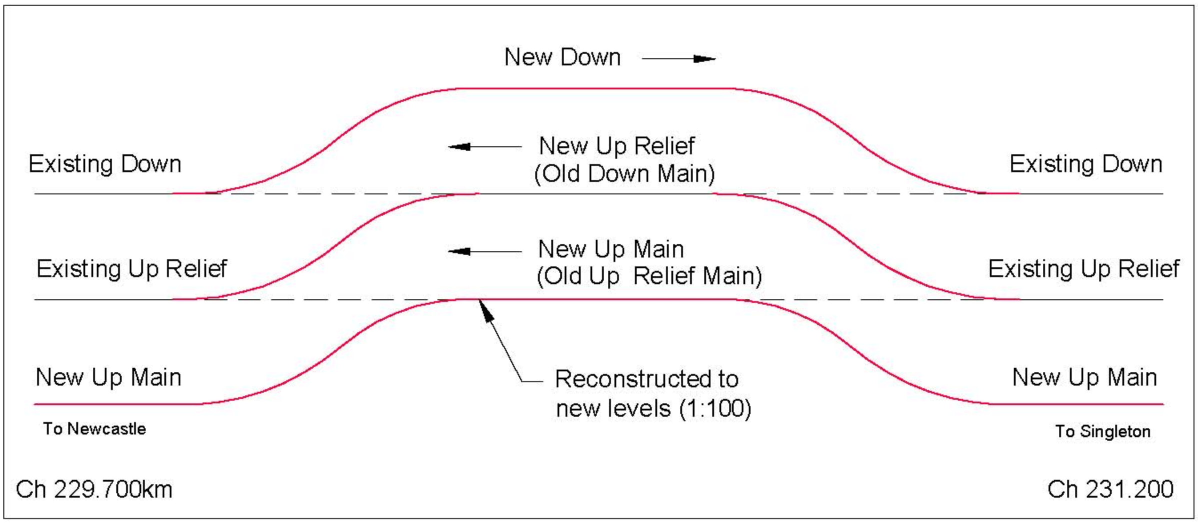

Figure 11 Track Slew Option

This option investigated the construction of a new Down main between the aforementioned chainages and to slew the existing Down to a new Down alignment. The existing Up main would then be slewed onto the existing Down main in this location allowing the new Up relief to be constructed over the existing Up main.

The proposed track slew would have the effect of moving the batter toe approximately 4-5m back towards the existing formation away form the New England Highway, reducing the height and extent of the proposed retaining wall.

GHD have subsequently discarded this option due the adverse impact on existing rail operations and associated cost implications.

4.5 Design Outputs

4.5.1 Horizontal Alignment

The track alignment for the new Up main starts at Whittingham with a track slew from the existing Up main. A right hand standard tangential turnout from the new Up main at chainage 235.070km connects the New Up main to the existing Up main (new Up relief). The new Up main re-joins the existing Up Main at Belford at chainage 224.220km.

The minimum horizontal curve radius on the alignment is 997m with an 80m transition curve at the Newcastle end and a 32m compound transition curve at the country end.

The turnouts are a 1:18.5 Vossloh tangential turnouts with a design speed of up to 80km/h onto the New Up main. Track centres are as discussed in section 4.4.

4.5.2 Vertical Alignment

The vertical track alignment of the New Up main is a function of:

- The ruling grade for the section of track from the crest of the Bank at approximately 226.165km to approximately 231.280km (falling –1.00% or 1:100 grade);
- The gradient at the tie-in with the existing Up main:
  - At approximately 224.220km at the Newcastle end, rising 1.242% or 1:80.5 grade; and
  - At approximately 236.444km, at the country end, 0.129% or 1:775 falling grade.
- The required vertical clearance at the overbridges and grade separation requirements at the level crossings.

The vertical alignment matches the existing grades and levels at the tie-in points on both ends of the new Up main and continues to follow the same gradient between chainages 224.220km and 226.170km on the Newcastle end and between 232.500km to 236.444km on the country end. At chainage 226.170km, the 1:100 grade commences with the New Up main falling lower than the existing main line, resulting in the New Up main being on a significant cut at a maximum height of 4.25m below the existing main line.

At approximate chainage 228.860km to 229.320km the New Up main and existing main line have similar grades and levels with minimal cut and fill. From 229.320km, the New Up main rises higher than the main line, resulting in the new Up main being in a significant fill at a maximum height of 3.25m above the existing main line.

From chainage 231.320km the new Up main follows the same level as the existing Up main to the turnout and track slew north of Whittingham Junction.

The general lengths of the vertical curves are 40m. Exceptions to this are at the crest of the Bank where a 140m long vertical curve has been used, and at 231.280km where a vertical curve of 80m arc length is adopted at the change of grade from 1:100 to 1:775.

4.5.3 Superelevation

The superelevation has been optimised for heavy haul coal trains running at 80km/h. The maximum achievable speed on the New Up main alignment for different types of trains is detailed in Table 4-1 below.

Table 4-1 Superelevation for Different Train Types

Station / Chainage (m)	Radius (m) / Transition Length (m)	Alignment Element	Applied Superelevation (mm)	Speed (km/h) Heavy Haul	Speed (km/h) Freight / Passenger	Speed (km/h) XPT
224220.081	1200	Circular (Turnout)	0	80	80	80
224284.881		Straight	-	80	110	120
224358.463	80	Transition	-	80	110	120
224438.463	997	Circular	70	80	110	120
225398.806	32	Transition	-	80	115	145
225430.806	1670	Circular	40	80	115	145
225557.662	70	Transition	-	80	115	145
225627.662		Straight	-	80	115	145
225929.973	70	Transition	-	80	115	130
225999.973	1294	Circular	50	80	115	130
226196.083	40	Transition	-	80	115	145
226236.083	1774	Circular	40	80	115	145
227097.44	70	Transition	-	80	115	145
227167.440		Straight	-	80	115	160
227573.836	40	Transition	-	80	115	160
227613.836	14000	Circular	0	80	115	160
227637.148	40	Transition	-	80	115	160
227677.148		Straight	-	80	115	160
228199.828	70	Transition	-	80	115	140
228269.828	1590	Circular	45	80	115	140
229229.925	70	Transition	-	80	115	140
229299.925		Straight	-	80	115	145
229522.028	90	Transition	-	80	115	145
229612.028	1623	Circular	45	80	115	145
230612.261	40	Transition	-	80	115	145
230652.261	1493	Circular	50	80	115	140

Station / Chainage (m)	Radius (m) / Transition Length (m)	Alignment Element	Applied Superelevation (mm)	Speed (km/h) Heavy Haul	Speed (km/h) Freight / Passenger	Speed (km/h) XPT
231190.667	90	Transition	-	80	115	140
231280.667		Straight	-	80	115	160
231438.001	40	Transition	-	80	115	160
231478.001	8000	Circular	0	80	115	160
231523.096	40	Transition	-	80	115	160
231563.096		Straight	-	80	115	160
232139.523	40	Transition	-	80	115	160
232179.523	10000	Circular	0	80	115	160
232201.01	40	Transition	-	80	115	160
232241.010		Straight	-	80	115	160
232855.732	60	Transition	-	80	115	140
232915.732	1950	Circular	35	80	115	140
233278.886	60	Transition	-	80	115	140
233338.886		Straight	-	80	115	160
233923.073	19991.63	Circular	0	80	115	160
233995.752		Straight	-	80	115	160
234206.110	20008.43	Circular	0	80	115	160
234232.217		Straight	-	80	115	160
235020.074		Straight	-	80	115	160
236239.059	40	Transition	-	80	115	120
236279.059	1200	Circular	65	80	115	120
236303.848	40	Transition	-	80	115	120
236343.848		Straight	-	80	115	120
236379.465	1200	Circular (Turnout)	0	80	80	80

4.5.4 XPT Speed Restrictions

The alignment of the New Up main does not comply fully with the standard ARTC design criteria. Specifically, this is the design speed of 160km/h for XPT trains. From Table 4-1, it can be seen 160km/h for XPT trains is not achievable for part of the alignment. This is due to the following constraints.

- Horizontal geometry near turnouts;
- Alteration of the horizontal geometry to avoid the Minimbah Relay Room; and
- The superelevation proposed is ruled by an 80km/h running for heavy haul coal trains, which limits the XPT speed to 120km/h.

4.6 Key Design Risk and Issues

Various design risks and design issues have been considered during the design process and are as follows.

4.6.1 Change in Batter Slope

The risk that is considered with this option is that if the slopes of the batters have to be increased, for example, from 2:1 to 3:1 or greater. The New Up main alignment would need to be redesigned to accommodate for the batters and the time frame of delivering the detail design of the project would increase.

4.6.2 Change of Turnout Type

The consequence of a change of turnout type is the alignment of the New Up main would need to be redesigned at the turnout ends. This would increase the time frame of delivering the detail design.

4.6.3 Relocation of the Minimbah Relay Room

If the horizontal track alignment is altered during detailed design, this is likely to impact the Minimbah Relay Room at chainage 225.980km. If the Minimbah Relay Room is required to be relocated, this will greatly impact on the design and construction of the project, in terms of both time and cost.

4.7 Construction Consideration and Implications on Design

4.7.1 Works Outside the Danger Zone

The track alignment follows the alignment at 6.5m offset to the centre of the existing Up main for approximately 7km. Track centres then increase up to a maximum distance of 18.5m due to cut and fill requirements. Where the New Up main is a significant distance from the existing main line, it has the benefit of being outside the danger zone. This is for approximately 5km of the route. Advantages of this situation include:

- Disruption to operational traffic during construction on the existing main lines is minimised;
- Suitable access to complete construction; and
- Safer work environment as machinery and workers are outside of the danger zone.

4.7.2 Works Inside the Danger Zone

For the remaining areas of track, work will be required within the danger zone. Careful consideration will be given to the staging of this work to enable it to be constructed within the existing possession program. These components include:

- The commissioning of the new structures;
- The installation of new turnouts for interface works at each end of the construction sections; and
- Tying top sections of new earthworks into the existing embankments.

Managing work in the danger zone under operating rail traffic is an issue that is to be progressed further during detailed design. Managing work in the danger zone has a significant impact on costs. This is due to safe-working personnel and safety barriers required to restrict access onto the live lines for both personnel and machinery. This is discussed further in Section 6.

4.8 Maintenance Consideration

Maintenance issues and procedures associated with the track alignment are presented in a separate report. The Preferred Options Maintenance Regimes is detailed in Appendix M. This maintenance regime report has undertaken an analysis of the three tracks, considering a total line capacity of 165 mtpa. The additional tonnage heading to Newcastle for export would need to be carried on existing uni directional Up and Down Mains from Belford to Maitland. This additional tonnage is an increase in the vicinity of 60 -70 mtpa and would therefore increase the maintenance costs and possession requirements significantly. Additional track possessions for the increased maintenance would also be harder to obtain, as it is assumed available train paths would be vastly reduced due to the increased line capacity.

In addition to the results in the report, the design superelevation has been optimised for the heavy haul trains with 80km/h running to minimise maintenance costs. As discussed, this also limits XPT trains to 120km/h. It is assumed that 66% of the train traffic will be running on that track will be heavy haul. The superelevation proposed is designed to keep rail wear and maintenance to a minimum.

4.9 Stakeholder Constraints

The major stakeholder constraints to the design are as follows:

- Uncertainty with the level crossings and their impact to the track alignment. A detailed discussion the level crossings for this project are included in Part 3 of this document; and
- Requirements for XPT trains speed to be reduced to 120km/h.

5. Signalling

5.1 Design Scope and Overview

The signalling works include the development of the proposed signalling layout arrangements and signalling functional specifications associated with the proposed New Up main. Modifications to integrate the new signalling arrangements with the existing arrangements and determining signalling system requirements to meet the core project objectives are also considered. This broadly includes:

- Positioning of signals, points, track circuits and overlap points;
- Defining interface arrangements to existing signalling;
- Selecting the types of track side equipments and systems;
- Preparation of a Signalling Functional Specification (refer to Appendix A);
- Preparation of the Signalling Reference Design;
- Calculations including headway, braking distance and overlap, and
- Indicative construction methodology detailing interim arrangements for signalling relocation works and final arrangements.

5.2 Design Methodology

Signalling concept design includes reviewing relevant existing signalling documentation from ARTC Standards, track gradient data and headway calculations from train simulation modelling completed by SAMROM during the Stage 1 works.

Development of signalling concept plans involved positioning of signals, signal numbering, positioning of track circuits, selection of normal lie of points, route selection, types of track circuits, type of signalling systems and headway calculations. This enabled the production of Signalling Functional Specification. The Signalling Functional Specification was prepared based on the requirements of ARTC as defined in the user requirements, core project objectives, concept track design and operations plan.

The preliminary signalling plans indicate the broad concept of the signalling requirements only following discussions with ARTC and the Signalling Alliance Group. Additional operations modelling of the concept design is required to confirm its robustness to given timetabling and headway requirements. The proposed signalling arrangements have been prepared to create a common understanding and to promote discussions between ARTC, operators, maintainers and constructors of the new and altered signalling arrangements. Signalling requirements will be finalised during the detailed design.

Signalling concept plans were submitted to the ARTC Hunter Valley's Signalling Alliance Group in November 2007 for review.

Selections of signalling equipments are based on Signalling System and Equipment Guidelines for Works in the Hunter Region (version 1.4) and advice from the ARTC Signalling Alliance Group.

5.3 Design Parameters

5.3.1 General

Heavy haul trains approaching Whittingham Junction from Singleton will be signalled clear of the junction onto the new Up main. An automatic signalled section along the length of the third track will maintain separation between consecutive trains scaling the bank. Trains will then be held after clearing the summit of the bank until the up main is clear.

Loaded coal trains approaching Whittingham Junction from Mount Thorley will be signalled onto the existing up or down main lines as per the current arrangements.

Passenger, light freight and occasional heavy haul trains approaching Whittingham Junction from Singleton will be signalled onto the existing Up or Down mains as per the current arrangements.

Down direction trains will operate as per the existing arrangements.

5.3.2 Operational Criteria

Operational criteria are detailed in section 1.4. Operational criteria are also clearly defined in the Functional Specification, included in Appendix A.

5.3.3 Level Crossings

At this stage of the project, it is envisaged no level crossings will remain. This will be confirmed during the detailed design.

5.3.4 Materials Selection Criteria

Signalling materials selection criteria is detailed in Table 5-1 below.

Table 5-1 Signalling Materials Selection Criteria

Item	Standard	Accepted	Comments
Interlocking	N/A	Microlok II	Expansion of existing relay based interlockings where appropriate.
Train Detection (Turnouts)	N/A	Axle Counters	Frausher Preferred
Train Detection (Plain Track)	N/A	AF/Jointless and Coded Tracks	CSEE preferred for high density block sections and Microtrax for low and medium density block sections. PSOIII for overlap and birth tracks where appropriate.
Backup Power Supplies	N/A	UPS and Motor Generator	
Point Machines	N/A	Cogifer Integrated	
Telemetry	N/A	Kingfisher Series II RTU’s	

5.3.5 Headways

One of the primary objectives of this project is to provide headways of 8 minutes or better over the Minimbah Bank for loaded coal trains. The addition of the new Up main will allow traffic to divert to one of two up direction lines creating effective headways of up to half that of any one line alone.

To effectively harmonise headways over the Hunter Valley network the new Up main is to have a designed headway of 10 minutes to match target headways for the network from Singleton. This will allow loaded coal trains to be diverted to the new Up relief main without causing a bottleneck effect at Whittingham Junction.

The combined effective headway for the New Up main and new Up relief (existing Up main) should exceed the target 8 minutes. This is to be confirmed during detail design under simulation.

Calculated headways for loaded coal trains only have been considered. Headways for this Passenger freight of XPT traffic will be determined during detail design under simulation.

5.3.6 Aspect Sequences

A non-standard signal aspect sequence is required on the new Up main due to large differences in attainable speeds between heavy haul and passenger services. This modified aspect sequence is required to satisfy the headway requirements for this line.

The modified sequence will require the use of repeated medium (pulsating yellow) aspects applicable to passenger services only. Drivers of heavy haul trains will be instructed to treat steady yellow aspects as the primary caution aspect and drivers of passenger services will treat the first medium as the primary caution aspect.

The aspect sequence proposed here is consistent with those currently in use in other areas of the Hunter Valley network.

5.4 Options Considered in Design Development

5.4.1 Junction Configurations

As discussed in Section 2.8, the original Fully Flexible junction configuration has been altered to a Base Case configuration in the preferred option selection process. This was due to reasons predominately relating to maintenance costs and infrequent use of redundancy levels of the Fully Flexible configuration.

The Fully Flexible junction configuration disregarded by ARTC is illustrated in Figure 12. The agreed Base Case configuration, also disregarded by ARTC, is illustrated in Figure 13. The final accepted junction configuration , which the signalling design is based on is illustrated in Figure 14.

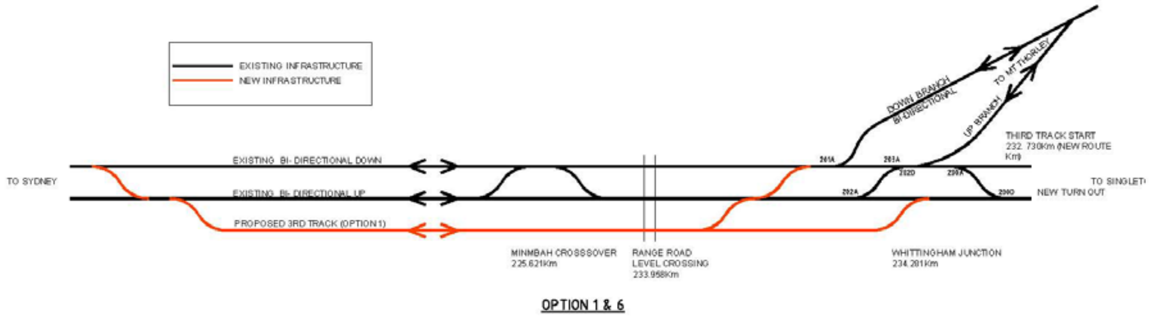

Figure 12 Disregarded Fully Flexible Junction Configuration

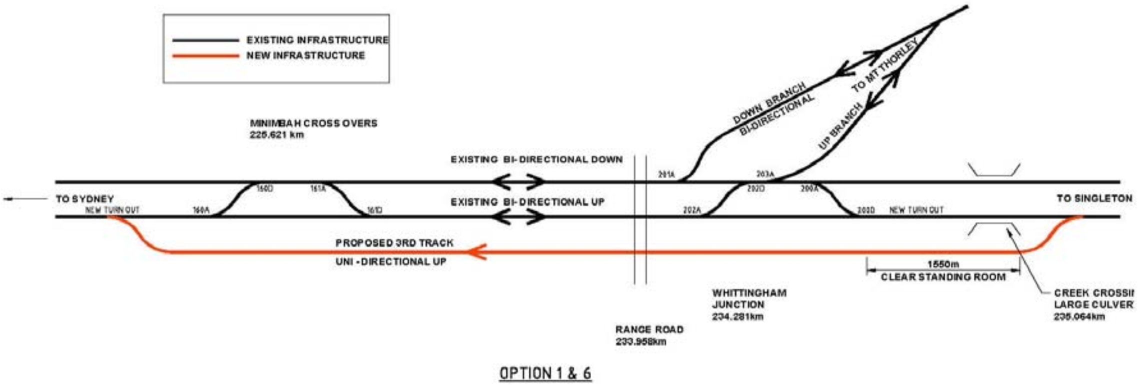

Figure 13 Disregarded Base Case Junction Configuration

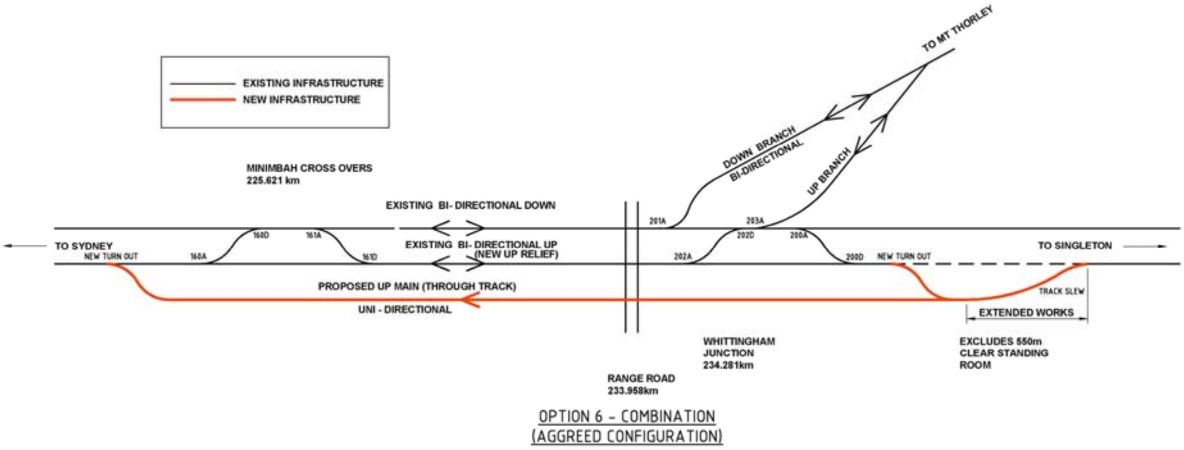

Figure 14 Accepted (Final) Junction Configuration – Combination Option

5.4.2 Minimbah Relay Room

In October 2007, GHD facilitated a meeting with the ARTC Signalling Alliance to agree upon the required signalling system arrangements and signalling service relocations. Originally, it was anticipated the Minimbah Relay Room would require relocation due to the location of the proposed new Up main. Upon completion of additional engineering, it was confirmed that this was not the case and the relay room could remain in its current location. The Signalling Alliance agreed to this approach due to the significant cost and resource savings.

It was also agreed at this meeting to use a computer based Microlok interlocking system for the proposed new Up main signalling works. Existing signalling infrastructure impacted by the project would be relocated and re-used.

5.4.3 Catch Points

Catch points have been added at the Belford end of the New Up main in order to provide operational flexibility.

5.5 Design Outputs

The design outputs for the concept signalling design are:

- Preliminary signalling plans indicating the broad concept of the signalling requirements for each project stage;
- Signalling System Configuration Diagram showing interlocking arrangement and train control systems details;
- A description of proposed signalling arrangements for each project stage (existing, interim and final); and
- A summary of headway and braking distance calculations;

These outputs are included in the Signalling Functional Specification included in Appendix A.

5.6 Key Design Risks and Issues

The key design risks and issues identified in the signalling concept design are:

- Increased signalling complexity including interfacing of new signalling arrangement with existing signalling system and track slews;
- Not enough capacity in existing Kingfisher telemetry systems, Whittingham relay room and phoenix screens;
- ARTC signalling documentation is not up to date. ARTC and Signalling Alliances are currently updating signalling records;
- Meeting delivery date due to limited availability of Alliance signalling resources for design, construction, testing and commissioning;
- Signal sighting distances will need to be risk assessed due to new signalling structures and other infrastructure. This will be completed during the detailed design;
- Breaking distance and stopping distance calculation using train simulation modelling will be required before detailed design progress; and

- Further assessment and consultation with stakeholders regarding concept design solutions of level crossings.

5.7 Construction Considerations and Implications on Design

Proposed interim signalling arrangement plans have been prepared to manage stage works associated with signalling relocation.

Construction considerations, which influenced the development of the signalling systems, are listed below:

- Existing signalling documentation;
- Signalling resources availability;
- Long lead items, such as signal cabling, delivery plans;
- Signal sighting distance;
- Train simulation reports;
- Interim and final signalling arrangements plans to manage staged works;
- Existing life expired MOSCAD telemetry system at Whittingham;
- Relocating existing signalling infrastructure; and
- Increased impacts on existing operations during construction

5.8 Maintenance Considerations

- Track centres between the existing Up Main and New Up main are a minimum of 6.5m allowing adequate room for maintenance of signals;
- Due to the close proximity of the New Up main to the Minimbah Relay Room, doors will be repositioned so that traffic movements can be made safely as well as providing a safe access for maintenance crews;
- Signalling infrastructure will be accessible by maintenance staff as per ARTC standards;
- Positioning of glued insulated rail joints (GIJ) will not be positioned in turnouts, on grades or curves unless approved by ARTC; and
- All new equipment proposed are as per ARTC's Signalling systems and Equipment Guidelines for Works in the Hunter Region (Version 1.4).

5.9 Stakeholder Constraints

The primary stakeholders for signalling design are:

- ARTC - Signalling Standards Group, Signalling Maintenance Group, Operations and Control Centre;
- Ansaldo STS - Hunter Valley and North Coast Signalling Alliance; and
- RIG.

The primary stakeholder constraints for the signalling design are:

- Availability of sufficient detailed design, construction and commissioning resources; and
- Minimising impacts to existing operations during construction and commissioning.

6. Bulk Earthworks

6.1 Design Scope and Overview

The bulk earthworks design includes civil design and 3D modelling supporting the track and road formations. This includes:

- Excavation and embankment configurations;
- Batter slopes and stability;
- Incorporation of maintenance tracks;
- 3D modelling; and
- Identification of suitable spoil disposal areas.

The earthworks design covers the extent of the project from chainage 224.200km to 236.500km. This includes coordination with the major infrastructure elements such as the Golden Highway Bridge, Range Road grade separation, Mudies Creek Bridge, major culvert structures, the New England Highway retaining wall as well as earthworks design associated with the signalling and maintenance roads.

The New Up main alignment is designed with a revised grade of 1:100 in contrast with the ruling grade of 1:80 for the existing main line. The consequence of the revised grade is that the New Up main becomes vertically separated in relation to the existing tracks. The track centres adopted are a minimum of 6.5m increasing to a maximum of approximately 18.5m at chainage 226.500km due to the need to allow for appropriate batter slopes between the new and existing tracks.

6.2 Design Methodology

The design of the bulk earthworks is interrelated with the design of the track alignment. An iterative approach was taken in the development of the track alignment. Offsets were calculated based on the desired cross section in the grade separated track section with the alignment modelled in Inrail. The alignment was then imported into MX and earthworks volumes produced.

GHD completed a number of iterations until a desirable earthworks balance was achieved with minimum encroachment on critical boundaries, such as the New England Highway and the privately owned nursery at chainage 231.400km.

Once a suitable alignment was established, the track alignment was locally adjusted to allow for site constraints. This included increasing clearances at Mudies Creek for the bridge construction and at the existing Minimbah Relay Room to avoid relocating signalling infrastructure. Once the alignment was complete, shoulder widening for signalling was included as well as adjustments to the cess drains for hydraulic capacity.

6.3 Design Parameters

The design parameters established for the concept earthworks design:

- Establish an earthworks model with a workable earthworks balance and cut and fill depths;
- Minimise land acquisition;
- Minimise impacts to adjacent buildings and non-rail infrastructure;
- Earthworks to be based on preliminary geotechnical advice;
- Minimise extent of retaining walls; and
- Provide adequate clearances for signalling and bridge works.

6.4 Options Considered in Design Development

6.4.1 Track Geometry and Earthworks Balance

A number of iterations were completed during the development of the track alignment and the earthworks. To achieve a desirable earthworks volume and minimise land acquisition and encroachment on the Golden Highway, the vertical track alignment was adjusted in an iterative process by translating the 1:100 grade incrementally and assessing the earthworks volumes.

The effect of translating the 1:100 grade was a modification of the depth of cut and fill relative to the existing track. The maximum fill depth relative to the existing track is at approximate chainage 230.300km coinciding with a pinch point on the New England Highway. Since a retaining wall is required at the New England Highway the height differential at this location was critical.

A vertical alignment with a relative fill of 3m and a relative cut of 7m was adopted from the iterative process. This option provided a favourable earthworks balance with the benefit of minimising the height of the retaining wall, allowing the use of a gravity wall such as gabion baskets.

6.4.2 Minimbah Relay Room

At the commencement of the concept design an assumption was made that all existing rail services including the Minimbah Relay Room would be relocated to the down side as an enabling works package.

During GHD reviews of the New Up main alignment, an opportunity to revise the proposed alignment an retain the relay room in its existing location was identified. To do this with the final New Up main alignment the relay room will require minor amendments to its current access arrangement with the relocation of the doors to another side of the structure. Due to the cost saving of retaining the relay room in its existing location GHD adopted the revised alignment in the concept design.

The modifications to the alignment as a result of the Minimbah relay room involved extending the length of straight track to just north of the relay room and modification of the preceding curve.

6.4.3 Track Slews

Earthworks associated with track slews were considered in line with the track alignment. For a description of track slews considered, refer to section 4.3.5 of this report.

6.5 Design Outputs

6.5.1 Cross Section

The design cross sections have been developed to provide for integration of the major project components as well as a consideration of constructability and maintenance. The typical sections conform to the requirements of TDS08. 1:2 batter slopes have been adopted uniformly on the project based on preliminary geotechnical advice. Typical cross sections are illustrated in Figures 15, 16 and 17 below.

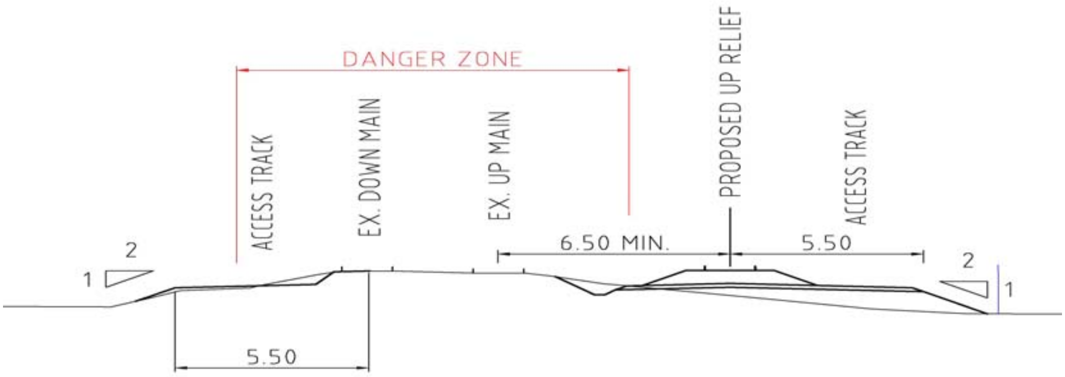

Figure 15 Type 1 Cross Section – Extended Formation

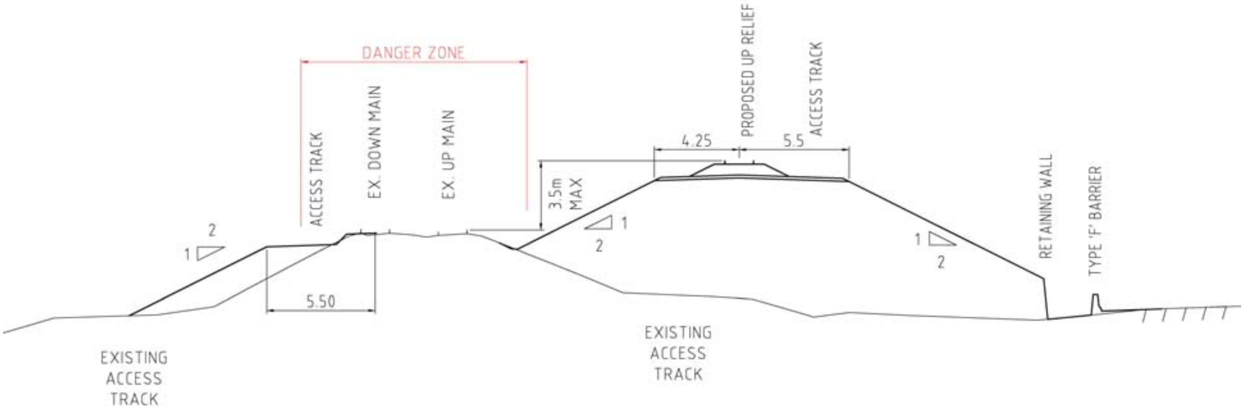

Figure 16 Type 2 Cross Section – Embankment to Formation

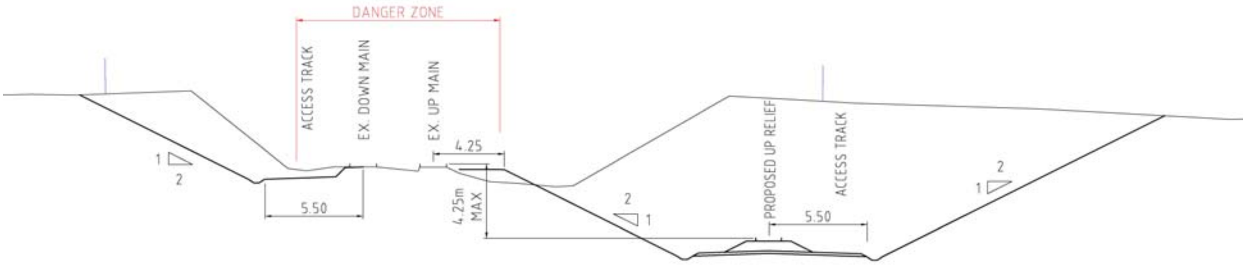

Figure 17 Type 3 Cross Section – Fill Embankment

6.5.2 Bulk Earthworks

Bulk Earthworks

The bulk earthworks figures are as follows:

- Cut – 443,400 m3;
- Fill – 238,200 m3;
- Capping – 17,400 m3;
- Maximum cut depth – 10.3 m; and
- Maximum fill depth – 8.8 m.

Down Side Access Track

The Down side maintenance access track has the following addition earthworks volumes. This quantity has been provided separately as these works will be completed as part of the enabling package (refer to section 20 for details).

- Cut – 59,400 m3;
- Fill – 44,700 m3; and
- Capping – 7,000 m3.

Golden Highway Road Re-Alignment

- Cut – 1,800 m3; and
- Fill – 63,000 m3.

Range Road

- Cut – 0 m3; and
- Fill – 80,000 m3.

The general earthworks are expected to be constructed from site-won fill materials, the structural zone is expected to be 1m deep and constructed from lime stabilised material that has also been won from site. The capping and ballast material is expected to be imported.

Poor earthworks materials may require additional treatment or importation of suitable materials. There is a risk that the claystone and siltstone present in the existing cuttings may be dispersive. At present we have assumed the claystone and siltstone will be suitable as general fill without treatment. The structural zone will be 1m deep based on an expected subgrade CBR of less than 3% in the general fill. It is expected that the structural zone will be constructed from lime or gypsum stabilised material won from site.

The concept design requires the addition of the following minor additional design elements during detailed design:

- Additional table drains;
- Diversion drains at the tops of batters;
- Benches in deep cuts;
- Tail out drains for culverts and any dam works required to existing dams;
- Modelling of capping on the down side access track; and
- Modelling of the structural fill zone.

At present allowances have been made within the design for these future additions.

6.5.3 New England Highway Retaining Wall

A retaining wall is required for the New Up main between chainage 230.300km and 230.680km as the earthworks batters encroach on the carriageway of the New England Highway. The retaining wall is a maximum of 2.9m high and has been designed as a gabion retaining wall due to ease of construction and cost. Other options investigated included a reinforced earth wall with precast panels.

The reinforced earth wall was not considered economical for the relatively low height of the wall. Additional issues with predicted subsoil drainage behind the reinforced soil also complicate this system.

A open drain has been constructed in front of the retaining wall to convey stormwater past the wall and reduce the risk of water ponding in the area as presently observed.

6.5.4 Access Tracks

Access tracks have been designed at track level on the Down side of the existing formation and also alongside the proposed New Up main. This configuration of access road allows for maintenance to be completed on the existing main line while the proposed New Up main remains operational; similarly the New Up main can be maintained without closure of the existing main line. The exact locations of the access tracks will be confirmed in the detailed design.

6.6 Key Design Risks and Issues

6.6.1 Lack of Detailed Geotechnical Information

As the geotechnical investigations have not been completed, the concept design has been based on preliminary geotechnical advice based on visual site inspections of the existing cuttings and available information on the area. Competition of the detailed geotechnical investigations may alter the design assumptions made to date.

6.6.2 Poor Cadastral Information

The cadastral information received from the Land Titles Office via ARTC property shows consistent inaccuracies when compared to the surveyed fence lines across the project area. A cadastral survey is required to confirm the locations of property boundaries, which will alter the land acquisition areas and potentially influence the design of the retaining wall at the New England Highway and treatments at other boundary pinch points.

6.6.3 Tying New Embankment to Existing

The existing fill embankments requires keying into the new embankment in accordance with RMP 07. The embankment in the vicinity of chainage 230.400km has been identified as being potentially unstable when exposed. The procedure for construction under rail traffic requires further assessment once the geotechnical investigations are complete. Alternative options such as shoring the existing embankment and stabilisations techniques have been considered during the concept design, however these will need to be confirmed in the detailed design.

6.6.4 Operational Safety

The difference in grade between the existing Up main and the new Up main introduces additional safety issues with trains operating at significantly different levels on the existing Up main and proposed new Up main. This situation may increase the severity of impacts on a train derailment and possibly result in a derailed train coming into contact with trains operating on the other lines by falling down cuttings or fill embankments. This situation has been raised with ARTC and requires close assessment during the risk management workshop scheduled during the detailed design.

6.7 Construction Considerations and Implications on Design

6.7.1 Construction Clearances and Safety Barriers

It has been agreed with ARTC that construction barriers are required to separate the construction activities from the danger zone. Barriers are proposed to be placed outside of the kinematic envelope of the existing Up main under possession. The barriers will remain in place while construction activities are being completed in the area. The track cross section has a minimum track centres of 6.5m which is adequate for the provision of barriers.

Barriers are proposed as a semi permanent structure consisting of a pre cast jersey kerb (approximately 1.2m high) with a chainwire fence attached to the jersey kerb. The fence is also approximately 1.2m high giving the barrier an overall height of approximately 2.4m.

Note that construction activities will need to be risk assessed during detailed design on a case-by-case basis.

6.8 Maintenance Considerations

- A new access track has been designed for the Down track for the extent of the project. The new access track is required to provide access to the existing tracks during construction and to allow the New Up main to remain in service during routine maintenance. The new track will be constructed as part of the enabling works for the project; and
- Batter slopes have been design at 1:2 throughout the project based on preliminary geotechnical advice. 1:2 batters have been selected as the existing steeper batters are showing evidence of erosion. The 1:2 batters will be more stable than the existing batters and are easier to revegetate for long term erosion protection.

6.9 Stakeholder Constraints

The primary stakeholder constraints for the earthworks are the effects of land acquisition on private property and road reserves. The property acquisition has been minimised wherever possible during the design.

7. Services

7.1 Design Scope and Overview

The design and construction of a new New Up main adjacent to the existing main impacts on a number of services and utilities. Engineering completed to date indicate the following will be affected by the proposed third track:

- Energy Australia;
- Telstra;
- Powertel / AAPT;
- Singleton Council;
- Private Irrigation Lines;
- AGL (Australian Gas Light);
- Hexham to Queensland High Pressure Gas Pipeline (HQP);
- SRA (State Rail Authority) 11kV distribution lines;
- RailCorp CCTV (Closed Circuit Television) Fibre Optic; and
- Rail Signalling.

The services relocation required to construct the proposed third track also includes services affected by the grade separation at Range Road level crossing and the realignment of the Golden Highway. This section of the concept design report serves as a preliminary impact assessment of the services in the area caused by the proposed works.

The sources of information used for this assessment include the following, listed in order of decreasing precedence:

- Ground services survey undertaken by Rail and Road Professional Services Pty Ltd in specific locations only. There locations include;
  - The entire area of the rail corridor between 234.400km and 233.800km;
  - Range Road road reserve 100 metres either side of the rail corridor;
  - The entire area within the rail corridor between 231.400km and 231.000km;
  - The Golden Highway road reserve, between the New England Highway and 100 metres west of the rail corridor; and
  - The entire area of the rail corridor between 224.400km and 224.000km.
- Aerial survey undertaken by Fugro Spatial Solutions;
- Information and plans acquired from ARTC, RailCorp and the various utility providers; and
- Dial Before You Dig data.

The scope of this report excludes the design of services relocations. This is to be undertaken as part of the Stage 3 – Detailed Design.

7.2 Energy Australia

7.2.1 Introduction

The following Energy Australia (EA) infrastructure is located within the impacted area and may therefore require relocation:

- 11kV High Voltage (HV) overhead distribution;
- 66kV HV overhead transmission;
- 132kV HV overhead transmission; and
- Underground 11kV HV distribution.

7.2.2 Overhead Transmission and Distribution Lines (11KV, 66KV and 132KV)

According to EA Network Standard 167 - Positioning of Poles and Lighting Columns; future rail crossings should allow for all poles to be located off rail property wherever possible. It is therefore likely that a number of EA poles and associated wires will need to be relocated for this project. The chainage for each of the identified EA distribution and transmission intersections including asset numbers of the poles are show below in Table 7-1.

Table 7-1 EA Distributions and Transmission Intersections

Chainage	Voltage (kV)	Aerial Crossing	Location	Pole Asset Numbers
224.650	132	Yes		EQ-50340, EQ-50341
228.800	66	Yes	Golden Highway	EQ-20028, EQ-20029, EQ-20030, EQ-20031
228.810	11	Yes	Golden Highway	EQ-20497, EQ-20408
229.200	132	Yes		EQ-20305, EQ-20306, EQ-20307, EQ-20308, EQ-20309,
229.400	11	Yes		EQ-20419, EQ-20420
231.620	11	Yes		SF-70279, SF-70837, SF-70292, SF-70293 SF-70294, SF-70295, SF-70296
233.950	11	Yes	Range Road	SF-40704

As well as the relocation of existing EA poles located within the impacted area, the clearances of the overhead crossings will need to comply with ARTC standard document “Requirements for Electric Aerials Crossing ARTC Infrastructure” (PYS 02 – RIC EP 10 01 00 05 SP).

7.2.3 Underground Cable

An underground direct buried electrical cable is located in the rail corridor parallel to the Down main to the north of Range Road (233.970km –234.380km). The concept design of the proposed arched tunnel wingwall for the Range Road grade separation is approximately 1m from the underground electrical cable at 234.065km. Relocation of the electrical cable may therefore be required to facilitate construction of the arch.

7.2.4 Design / Relocation Considerations

In accordance with EA Network Standard 167 impacted poles will be relocated so that they lie outside the rail corridor. Where possible the track alignment and associated earthworks have been designed / altered so that pole relocation is not required. In such cases safety fences may be required to clearly identify the rail corridor boundary. This will be subject to a risk assessment during the detailed design.

7.2.5 Construction Considerations

EA network standard “NS 135 – Specification for the Design and Construction of Overhead Sub-Transmission Lines (2001)” specifies that spun-reinforced, pre-stressed concrete poles are preferred for new 66KV and 132KV lines. EA has indicated that there is a 12 month lead time for the fabrication and delivery of concrete transmission poles. As relocation of the 66KV and 132KV lines is likely to be prolonged, careful consideration as to the impacts of this on the construction program of the new rail is required in the future stages of work.

7.3 Telstra

7.3.1 Introduction

The following Telstra infrastructure is located within and adjacent to the impacted area and may therefore require relocation:

- Local copper communications;
- Mains copper communications; and
- Fibre Optic communications;

It should be noted that the majority of the Telstra assets adjacent to the impacted area have been located by a ‘dial before you dig’ search only, as private property could not be accessed during this commission. The large inaccuracies inherent in such data make it difficult to accurately assess the impact of the project on Telstra’s assets. A more accurate assessment of the relocation works is therefore required during the detailed design upon completion of a full services survey. Detailed design will also require Telstra to be engaged to undertake design works.

7.3.2 Mains

Telstra copper mains run along the Up side of the existing rail approximately parallel to the New England Highway between 231.120km and 236.450km. Between 231.120km and 234.000km the Telstra mains line runs in close proximity to the existing main line. Part or all of this section may therefore require relocation. Beyond 233.970km however the mains line is adequately offset from the existing and proposed rail line and as such will not require relocation.

The proposed grade separation and realignment of the Range Road intersects with the Telstra mains line north of Range Road. The proposed new road at this location will be on fill and it is therefore envisaged that relocation of the cable will not be required. This assumption is to be confirmed as part of the detailed design.

7.3.3 Local

A Telstra local line runs along the up side of the existing rail roughly parallel to the New England Highway between 231.120km and 234.000km, in close proximity to the existing rail. Part or all of this section may therefore require relocation.

An existing Telstra local cable intersects with the proposed rail formation at 231.250km. Although the proposed new New Up main is in slight fill at this location the depth of the cable may need to be increased to comply with the minimum depth of 1.6m below Top of Rail (ARTC standard ETG-17-01). The cable may also need to be installed within a conduit to allow for maintenance.

A local Telstra line also runs within Range Road and intersects the proposed New Up main. Construction of the New Up main as well as the Range Road grade separation may therefore require relocation or protection of this cable.

7.3.4 Optical fibre

A Telstra optical fibre cable runs parallel with the existing rail corridor on the Up side between 234.000km and 236.450km. A preliminary survey and site inspection indicate that the cable is approximately 5m outside the existing corridor fence line. Based on preliminary information, the cable passes under the footings of the proposed arched tunnel wingwall of the Range Road grade separation. It is therefore likely that relocation of the optical fibre cable will be required to facilitate construction of this structure.

If there is inadequate slack to relocate the existing optical fibre cable a new cable may need to be installed. Telstra requires that new cables span the length between existing joints, as they do not permit the construction of new cable joints. Telstra have advised that the distance between optical fibre joints for their infrastructure can be up to 10km and as such the cost of replacing an existing cable would be substantial. Relocation or protection of the existing cable is therefore the preferred solution.

7.3.5 Design / Relocation Considerations

Where possible the Telstra infrastructure requiring relocation will be relocated adjacent to and outside of the new rail corridor. This will facilitate maintenance of the infrastructure without the need for rail safety protection and associated documentation.

7.3.6 Construction Considerations

Construction in the vicinity of Telstra infrastructure should be undertaken under the supervision of an authorised Telstra representative.

7.4 Powertel / AAPT

7.4.1 Introduction

The construction of the proposed New Up main at Minimbah will impact upon the Sydney to Brisbane Powertel / AAPT fibre optic line, which runs adjacent to the impacted area. Within the boundaries of the rail corridor the optic fibre has been located by a ground survey using visible cable markers. Outside the boundaries of the rail corridor the cable has only been located by a ‘dial before you dig’ survey due to the restricted access to private property. Further survey of the cable will be undertaken for the detailed design.

7.4.2 Sydney to Brisbane Powertel / AAPT Fibre Optic

The Powertel optic fibre cable runs on the Up side of the existing rail between 236.450km and 234.000km and on the down side of the existing rail between 234.000km and 229.150km. The cable intersects the rail at the following locations:

- 234.000km;
- 229.170km; and
- 224.620km.

The Powertel optic fibre cable also intersects the proposed Golden Highway realignment and the proposed Range Road grade separation. The proposed Golden Highway and Range Road realignments are both in fill where intersected by the Powertel optical fibre cable. It is therefore envisaged that relocation of the cable will not be required. This assumption is to be confirmed as part of the detailed design.

According to works and executed plans the majority of the optical fibre cable is direct buried at a depth of 900mm. The cable has been installed within a polyethylene duct where it crosses the rail formation, Range Road and the Golden Highway.

7.4.3 Design / Relocation Considerations

Where possible the Powertel optical fibre cable will be protected and/or relocated. Severing of the cable is to be avoided if possible as a new cable would need to be installed between the existing joints which are commonly located at 10km spacings, at significant cost.

7.4.4 Construction Considerations

Construction in the vicinity of Powertel infrastructure should be undertaken under the supervision of an authorised Powertel representative.

7.5 Singleton Council

7.5.1 Introduction

A Council owned water main exists within the Golden Highway road reserve between the New England Highway and the rail over bridge. The main terminates at a non return valve approximately 100m east of the existing rail overpass bridge. Council has indicated that they intend to extend the mains water pipe past this point in the future.

7.5.2 Mains Water

The main is polyvinyl chloride (PVC) and varies from 100mm to 200mm in diameter. The main passes under the Golden Highway to the east of the rail overpass bridge and is hung from the northern side of the bridge.

The proposed realignment of the Golden Highway and associated new bridge will require relocation of this water main. Council have indicated that their preference is to replace the existing 150mm mains pipe with a 250mm mains pipe to allow for future expansion in the area.

It also appears that the non return value on the southern side of the Golden Highway may need to be relocated, however this will be confirmed during detailed design.

7.5.3 Design / Relocation Considerations

Three options were considered for the main crossing of the rail line:

- *Option 1 - Incorporation of the pipe into bridge design (ie under footpath);*

This was identified as the Council preferred option. It involves the installation of the pipe within a void in the footpath or road shoulder, allowing for easy access and maintenance without the requirement of entering the rail corridor. However, as there is no specific requirement for a footpath on the bridge, as well as the increased pipe size (150mm-250mm) this option would add substantial cost to the bridge construction and is the least cost efficient option:

- *Option 2 - Bored pipe under the existing and proposed rail lines;*

This option involves boring of the proposed 250mm pipe under the proposed new and existing rails. This option was identified as being a more cost effective alternative to option 1. However this option has been flagged by Council as being a last resort due to the long term cost of maintenance and the inability to access the pipe if required:

- *Option 3 - Hanging of new pipe off the new bridge structure;*

This option is the most cost effective solution for the mains crossing of the railway. Council have requested provision in the bridge design for the water main above the road deck but outside of the crash protection barrier and connected to the bridge by hangers. Council's preference for this option is the construction of a welded steel pipe:

- Recommendation;

Option 3 is the most cost effective solution and has been identified by Singleton Council as preferable to thrust boring under the rail (option 2). ARTC have also verbally accepted this solution. Option 3 is therefore the recommended option to be progressed through the detailed design.

7.5.4 Construction Considerations

Council have indicated that construction of the pipe can be carried out by Council or an alternate contractor. However as the pipe is a Council asset supervision will be required by an authorised Council representative if the works are undertaken by a contractor other than Council.

7.6 Private Irrigation Pipes

7.6.1 Introduction

According to information provided by ARTC the proposed new New Up main intersects 5 private water pipes at the following locations:

- 231.215km 152mm dia water pipe through 229mm conduit;
- 231.240km 51mm dia pipe through 76mm galvanised pipe;
- 231.50km 203mm steel water main within 356mm dia concrete pipe;
- 226.170km 400mm polyethylene pipe under track owned by Hunter Wine Country; and
- 226.230km 200mm pipe owned by Wyndham Estate.

It should be noted that these irrigation pipes have been identified by an ARTC database and associated plans. These plans in some instances are in excess of 40 years old and must therefore be verified on site. As part of the detailed design a ground survey including potholing will be required to clarify the existence of these pipelines, their precise location and relevant specifications and asset owners.

7.6.2 231.215km

According to a plan for this irrigation pipeline (Plan No. BK6-3101, 15 March 1966) this pipe is located immediately east of the existing private level crossing. The pipe is 152mm in diameter and installed within a 229mm dia conduit under the tracks, intersecting the rail at approximately 90 degrees. Plan No. BK-3101 is located in Appendix D.

7.6.3 231.240km

According to a plan for this irrigation pipeline (Plan No. BK6-3208, 14 November 1967) this pipe is located immediately west of the existing private level crossing. The pipe is 51mm in diameter and is encased by a 76mm diameter galvanised piped under the existing tracks, intersecting the rail at approximately 90 degrees. Plan No. BK-3208 is located in Appendix D.

7.6.4 231.50km

According to a plan no. BK6-3186 (13 April 1967) this pipe consist of an 203mm diameter steel water main installed within a 356mm bored concrete pipe under the existing rail tracks, intersecting the rail at approximately 90 degrees. Plan No. BK-3186 is located in Appendix D.

7.6.5 226.170km

According to plan no. 100-474 (5 July 1999) this pipe is a 400mm diameter polyethylene pipe constructed within a thrust bored 600mm diameter concrete encasing pipe under the existing rail tracks at approximately 90 degrees. Plan No. 100-474 is located in Appendix D.

7.6.6 226.230km

According to plan no. BK13/4070A (6 September 1985) this pipe is a 200mm in diameter and crosses under the existing tracks at 90 degrees. Plan No. BK13/4070A is located in Appendix D.

7.6.7 Design / Relocation Considerations

The existence, location and relevant specifications for the above pipelines will be confirmed by the detailed design survey using a combination of electronic location and potholing where required. Once the pipes have been located as the specifications for each are established, it will then be determined where relocation is required.

Where relocation is deemed necessary new pipes will be designed in accordance with ARTC standard ETG-17-01 and AS 4799 – 2000.

7.6.8 Construction Considerations

Thrust boring under the existing rail tracks should only be undertaken during rail possessions.

7.7 AGL (Australian Gas Light)

A ‘dial before you dig’ request has identified AGL high pressure gas pipes adjacent to the proposed site. South of Range Road a 250mm polyethylene (PE) pipe runs along the northern side of the New England Highway. A 110mm PE pipe also extends to the abattoir on the Up side of the main line.

North of Range Road the pipe follows a shared easement with the 66KV overhead transmission line to Orchard Lane, which extends south from the township of Singleton.

The AGL infrastructure identified on the ‘dial before you dig’ plans do not intersect the existing or proposed rail lines and are adequately setback to remain outside the extended rail corridor. Therefore, no relocation of AGL infrastructure is anticipated. This will be confirmed as part of the detailed design.

7.8 Hexham to Queensland High Pressure Gas Pipeline (HQP)

The proposed Hexham to Queensland High Pressure Gas Pipeline (HQP) was identified during Stage 1 as being adjacent to the proposed works, and intersecting the proposed rail corridor at 2 locations.

However, it has been since established that the proposed route for the Hexham to Queensland Pipeline passes north of Singleton and will not impact upon the proposed Minimbah Third Track Project. Written confirmation to this extent has been received from Mr Bob Otjen of URS Corporation.

7.9 Rail Services

7.9.1 Introduction

The following rail services infrastructure is located within the rail corridor over the length of the project:

- SRA (State Rail Authority) 11kV distribution lines;
- Railcorp CCTV (Closed Circuit Television) Fibre Optic; and
- Rail Signalling.

It should be noted that the majority of the rail services infrastructure, particularly the rail signalling and CCTV cable, has been located from hand sketched plan drawings obtained from ARTC. This information is considered as ‘indicative’ only due to the uncertainty of such data. Survey is required to locate this infrastructure with a higher degree of accuracy.

7.9.2 SRA 11kV Distribution Dines

A site inspection of the impacted area revealed the existence of an 11kV SRA reticulation network, which runs along the Up side of the existing rail along the length of the project. However this network is being progressively decommissioned between Newcastle and Muswellbrook and will be removed in by August 2008. Written confirmation to this extent has been received from Mr Geoff Berry of ARTC.

7.9.3 Railcorp CCTV (Closed Circuit Television) Fibre Optic

The Maitland to Scone RailCorp CCTV cable runs parallel to the existing Up main for the entire length of the proposed project. The CCTV cable is installed within a separate trench to the rail signalling for the entire length with the exception of the Golden Highway, Mudies Creek, and Range Road intersections. Although the majority of the cable has been direct buried according to the information available, some sections have been installed in conduits.

There are no station platforms over the length of the project. We understand that there are no cables or connections and therefore no constraints for the relocated cable route.

7.9.4 Rail Signalling

According to the CCTV cable route drawings forwarded from ARTC, the rail signalling main cable(s) run along the Up side of the main line between 236.450km and 226.000km, and on the Down side between 226.000km and 224.215km. This is supported by limited existing survey (including potholing and electronic location) of the rail signalling completed as part of this commission.

It is believed that the rail services main consists of the following:

- 2 power main cables;
- 3-4 signalling main cables; and
- Fibre optic cable.

Confirmation of the above will be achieved through the detailed survey and associated services search and potholing.

Based on the information acquired from the concept services survey, site visits and schematic plans, it appears that almost the entire length of the of the signalling services lies within the impact zone of the proposed project.

7.9.5 Shared Trenching

The rail signalling main cables and RailCorp CCTV fibre optic cable both lie within the proposed impacted area and will therefore require relocation over the length of the project. As both of these assets run parallel to the existing track a shared trench can be utilised for their relocation. Shared trenching will reduce the earthworks required for the relocation of these assets and subsequently increase cost efficiency.

Both RailCorp and ARTC have conveyed conceptual support for shared trenching of their services.

No other opportunities to utilise shared trenches have been identified for the other services, however, both Telstra and Powertel have given verbal support for shared trenching where feasible.

7.9.6 Minimbah Relay Room

The Minimbah Relay Room has been identified as a constraint for the design and construction of the proposed new rail. Whilst it was acknowledged that the construction of a new Relay Room on the Down side of the existing track would take considerable time and significant cost, it was unclear whether designing a new track around the Relay Room (RR) was feasible. Three options were subsequently tabled and assessed:

- *Option 1 - Leave RR in current position with new rail alignment on West side of RR.*

This option requires the construction of a new track between the existing rail tracks and the Relay Room, whilst complying with the minimum clearance requirements of ARTC standard BDS12 ‘Structure Gauge 2004’. According to aerial survey conducted over the site, the proposed new rail is setback approximately 2.805m from the nearest corner of the Minimbah RR. The minimum setback of the rail in accordance with the BDS12 is 2.175m (taking into account superelevation and curve radius):

- *Option 2 - Leave RR in current position with new rail alignment on East side of RR.*

This option requires the construction of a new track around the Minimbah RR, such that the RR is located between the existing and proposed new tracks. This option is considered undesirable due to safety issues with access and the increased cost of land acquisition:

- *Option 3 - Relocate RR to the down side of the existing alignments.*

The option involves the construction of a new relay room on the Down side of the existing rail tracks. This option is the most expensive and time consuming option and creates significant risks to the program due to signalling resources and available tack possessions:

- *Recommendation.*

Option 1 is the most cost effective option and is compliant with the minimum horizontal clearance requirements of ARTC standard BDS12 ‘Structure Gauge 2004’. Option 1 is therefore the recommended option to be progressed through the detailed design.

7.9.7 Design / Relocation Considerations

It is proposed that the new signalling and CCTV cables be installed in conduits for the following reasons;

- Ease of maintenance;
- Provide flexibility for construction (ie conduits can be laid early and cables pulled through at a later date); and
- To protect the cables.

Maintenance pits for the rail signalling and CCTV optical fibre cables will be staggered and spaced in accordance with the requirements of ARTC and RailCorp. A standard layout drawing (from ARTC standard SC 09 01) for rail services installed in conduits can be found in Appendix E.

As stated previously the rail signalling main cables and RailCorp CCTV fibre optic cable both lie within the proposed impact area and require relocation over the length of the project. A number of alignment options were considered for the relocated cable route, including:

- *Option 1 - Relocate on Up side.*

Construction of a new cable route on the Up side of the new rail has a number of constraints including the close proximity of the New England Highway and existing services, primarily Telstra. This option would also require boring under the proposed construction area to the existing rail and is therefore not cost effective:

- *Option 2 - Relocate to down side in centre of access track.*

The option involves the construction of a new cable route under the centre of the proposed down side rail access track. This is considered to be a practical solution however cannot be undertaken until the earthworks for the access track is complete. The cable route for this option is also within 4m of the existing rail and therefore does not comply with section 5.2 of ARTC standard SC 09 01 – Construction of Cable Route and Associated Civil Works:

- *Option 3 - Relocate to down side on outside of access track.*

This option is similar to option 2 with the cable route on the outside of the rail access track. This option is likely to be subject to more wheel loading than option 2 and is located in close proximity to the proposed cess drainage channel:

- *Option 4 - Relocate to down side at natural ground level.*

This option involves the construction of a new cable route on the Down side at natural ground level and outside the impact area. This option has few constraints can be implemented prior to the construction of the access track on the down side.

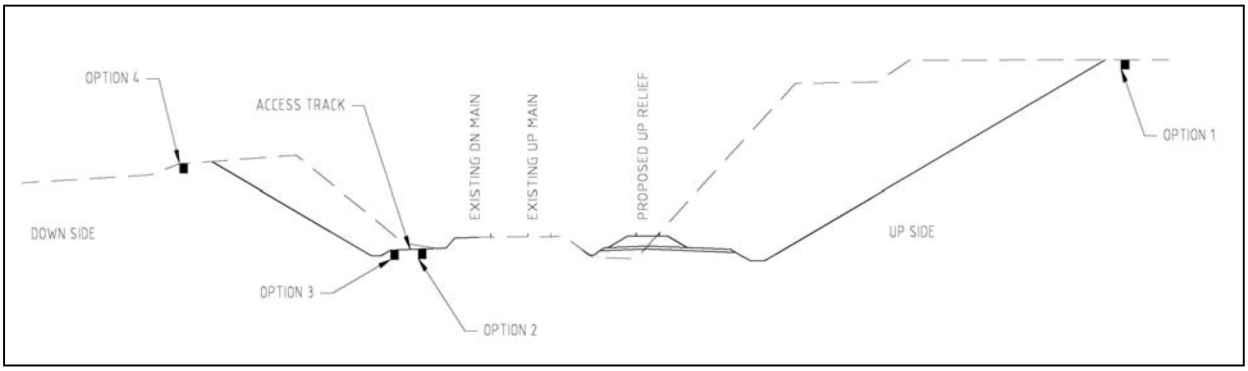

Figure 18 Rail Services Cable Route Options

- *Recommendation;*

Option 2 has been identified as the preferred solution due to its simplicity and ease of access for maintenance. However, in order implement this solution a waiver is required from ARTC as the route is within the minimum ARTC rail offset of 4m. If a waiver is not approved an alternative solution to option 2 will be required.

Constraints such as existing services (i.e. power poles, communications) and potential delay for earthworks will impact upon option 2. West of Range Road the existing signalling services and the Whittingham Junction may necessitate an alternate solution to option 2 at this location.

The final solution to this issue will be determined during detailed design. It is likely that a combination of options 1, 2, 3 and 4 will be required over the length of the project.

7.9.8 Construction Considerations

For the existing main line to remain operational throughout the construction phase the signalling and RailCorp CCTV fibre optic cables will both need to be relocated and commissioned prior to commencing construction of the proposed new Up main. A possession will be necessary to commission the new signalling and RailCorp CCTV cables.

It is understood that relocation of services cannot commence until Part 3A approval is received. This is a significant risk for the program as construction of the New Up main cannot commence until the services within the impact area have been temporarily or permanently relocated.

8. Drainage

8.1 Design Scope and Overview

The review and design of the drainage required for the New Up main and road formations included two systems. These were:

- Cross drainage system; and
- Track drainage.

The cross drainage system consists of both culverts to convey external catchment flows and bridges, while the track drainage includes the cess drainage. Rail corridor runoff is usually catered for in open channels however given spatial limitations for this project, pit and pipe systems are also included.

8.1.1 Cross Drainage

Culverts

As outlined in previous sections, the proposed track has a lower maximum grade compared to the existing track. This results in some areas of vertical separation. For the drainage system to cater for this, several culvert options were developed, including:

- Extension of existing culverts where possible;
- Additional culverts where extension was not practical;
- Reconstruction of features both upstream and downstream of crossings; and
- Abandonment of redundant culverts.

Existing culverts within the rail corridor are to be maintained and, where possible, extended. The culvert extensions are to be the same size as the existing structure and where possible, the same grade is to be maintained. It should be noted that the concept design has excluded confirmation of overland flows and sizing of existing culverts. There will be a risk that existing culverts may increase in size when the overland flows are confirmed. These aspects will be considered at the detailed design stage.

Where existing culverts could not be easily extended, alternatives were considered. Stormwater pits were introduced to allow for transitioning between the invert of the new and existing sections of culverts.

Bridges

There are two major waterway crossings in the investigation area. These are Mudies Creek and Doughboy Hollow (bridges at 234.290km and 235.070km. A preliminary review of a previous study of Mudies Creek provided a range of concept flood levels for this structure.

No investigation of Doughboy Hollow was undertaken during the concept design however it has been included for investigation as part of the impending environmental assessment.

8.1.2 Track Drainage

The profile developed for the third track includes a central cess drain. The size and configuration of this cess was developed to satisfy ARTC requirements while minimising earthworks and property acquisition.

Given the spatial limitations for this central cess, a pit and pipe system was incorporated. The pits incorporated to collect runoff were placed periodically along the cess with the pit inlet including a lobster grate box. This grate will reduce the likelihood of ballast falling into the pit and blocking the system. Flow collected in this pit will be conveyed via a pipe under the outside cess prior to discharging at a culvert.

In one location along the flatter section of the track, it is not possible to discharge to a natural waterway. A detention basin is therefore designed to provide a discharge location for the cess drainage. The inclusion of this basin minimises ponding in the immediate area of the proposed track.

8.2 Design Methodology

8.2.1 Cross Drainage

The methodology adopted for the concept design for the cross drainage includes:

- A desktop study to assess existing information including internal and external rail corridor survey, cadastal and topographic information for catchment delineation;
- Catchment delineation from available topographic and survey information. From this the peak runoff was calculated for ARTC’s design requirement of a 50 year Average Recurrence Interval (ARI) capacity;
- Review of the asset register provided by ARTC for the existing culverts within the investigation area. This review indicated that some data was missing. A site visit was subsequently completed to obtain key missing information required for the concept design;
- Assessment of each crossing and where possible, extension recommended;
- Investigation of alternatives where an extension of an existing culvert was not practical;
- Review of locations where existing culverts were to become redundant;
- Assessment of the potential impact of culvert works on features outside the rail corridor such as existing farm dams, watercourses and roads;
- Review of the 1996 study undertaken by Water Resources Consulting Services (WRCS) for the Mudies Creek bridge upgrade; and
- Extrapolation of flood levels for a range of storm events from the WRCS study.

Culverts

An assets register of existing culverts under the section of rail being investigated was provided by ARTC. The assets register contained only a general dimension description, type of drainage crossing and chainage location. No specific information was provided on either invert or lengths. Additional dimensions and culvert types were obtained during a subsequent site inspection.

During the preliminary desktop study, it was assumed that all culverts within the investigation area had sufficient capacity to cater for the design storm event in accordance with ARTC design guidelines. It is also assumed that the culverts are functioning adequately. On this basis, to accommodate the New Up main each existing culvert is extended.

A simple extension of a number of structures was not possible due to vertical separation and hence several other treatments were considered including:

- Installation of new culverts by under-boring the existing track;
- Incorporation of a pit to transition between the inverts of the existing and proposed culvert sections;
- Decommission existing culverts where redundant; and
- Re-align natural waterways upstream and downstream of culverts to transition as required.

Where the proposed works for the track upgrade are altering the existing catchment configuration, a review of the capacity of the culvert was undertaken.

During the concept design, it was assumed that all new culvert lengths would be a HELCOR style culvert. This assumption will be investigated further during the detail design.

Mudies Creek

The waterway assessment of Mudies Creek Bridge was undertaken by WRCS in 1996. This study provided flood levels for the 100, 1000 and 2000 year ARI design storm events. However to establish the flood level for more frequent storms, extrapolation was required. A review of the WRCS provided peak flow rates for the 10 year ARI storm event and a preliminary assessment of the creek profile enabled the determination of the 10 year ARI flood level.

This preliminary assessment assumed that the properties of the bridge as detailed in the WRCS report and accompanying design drawings are still current. A more detailed hydrology and hydraulic assessment will be undertaken as part of the detail design.

8.2.2 Track Drainage

The methodology adopted for the concept design for the track drainage included:

- Size cess open channels using Mannings equation;
- Optimise open channel configurations in conjunction with the earthworks design;
- Determine pit inlet capacities for lobster grates using methods outlined in the design program DRAINS;
- Establish a maximum catchment area to generate flow equivalent to pit inlet capacity;
- Nominate maximum pit spacing to satisfy both ARTC design guidelines and maximum catchment areas; and
- Size detention basins to cater for a 20 year ARI standard with storage volumes determined using the PRM.

Cess

The design of the cess drainage was undertaken as an iterative process with the earthworks design. The initial sizing of the cess catered for the 50 year flow throughout. To convey this flow a large open channel for both the central and external cess is required. The flow on effect is an increase in the extent of works, which in turn requires significant property acquisition.

To reduce both earthworks and property acquisition, the cess design was reviewed. By incorporating a pit and pipe system in conjunction with the open channel, the size of the open channel was reduced.

The current open channel configuration has adopted the dimensions suggested in the ARTC design specifications and also considers the likely maintenance requirements.

With the inclusion of the pits in the cess drainage system, lobster grates have been recommended. To determine the maximum spacing of these pits, it was first necessary to assess the inlet capacity of the lobster grate. This was done using a methodology defined in the design program DRAINS.

The catchments to each pit were defined by the high point in the capping under both the existing and proposed track. The length of channel contributing to the pit was then varied to generate a flow equivalent to the grate inlet capacity. This process established the maximum spacing of pits within the central cess. A comparison was then undertaken with the ARTC design guidelines. From this a maximum pit spacing of 50m was nominated.

Detention Basin

In a flatter section of the track, there is no discharge point to an existing waterway. It is therefore necessary to construct a detention basin to form the discharge location for the track drainage. This basin will allow runoff to be directed away from the area in the immediate vicinity of the rail line thereby minimising ponding.

Other Features

Further to the design of the drainage associated with the proposed track works, there is an interaction at several locations with features outside the rail corridor. Of particular note are two farm dams and the re-alignment of a natural waterway.

One farm dam is upstream of a culvert extension while the second is downstream of another structure. The relationship between the inverts of the culverts and the dams is such that there is no practical transition between these features. It is therefore likely that both dams will require some remedial works such as lowering the base of the dam or relocation of the dam as a whole. These issues will be given further consideration during the detail design.

Another area that requires more detailed investigation is the interaction of flows from external catchments along the New England Highway with the proposed works. There are several culverts under the Highway and the flows through these culverts are directed towards either the proposed retaining wall or earthworks embankments. During the detail design stage, the size of these structures would be obtained and a more detailed assessment of the flow regimes undertaken.

8.3 Design Parameters

The design parameters for the concept design of drainage include:

- Maintain existing flow regime through the rail corridor;
- Minimise impact of the works on existing natural waterways; and
- Minimise extent of works required outside the rail corridor.

8.4 Options Considered in Design Development

During the concept design development several options were considered for the track drainage system. As previously indicated, an open channel system was developed to convey all runoff within the rail corridor however due to spatial limitations, this was further developed to incorporate a pit and pipe system.

The spacing of the pits along the central cess was nominated at 50m in accordance with ARTC guidelines however, the proposed pipe system runs parallel to the track alignment rather than perpendicular to it and discharging to an outside cess.

An internal review of the track drainage system has been undertaken by GHD, which has identified some maintenance issues associated with accessibility of the proposed longitudinal drainage system. Initial feedback received from ARTC on the 19 December 2007 on this topic confirmed these issues. ARTC have stated they are prepared to review the ARTC standards in light of these issues to provide a more maintainable solution.

GHD have identified other options such as removing the longitudinal pipe system and draining to a deepened cess drain alongside the maintenance track. This will increase the land acquisition. A second option is to remove the crown in the extended formation and remove the central cess, allowing surface water drain through the ballast to the cess alongside the maintenance track. This option also has an affect on property acquisition.

These proposed drainage systems need further discussion with ARTC prior to detailed design.

8.5 Key Design Risks and Issues

A number of key design issues have been identified. There are:

- Scour protection will be required for extended or new structures;
- Re-alignment of waterways upstream and downstream of some culverts;
- Interaction of structures with existing water bodies and farm dams needs further consideration;
- Treatment of redundant structures within the existing alignment requires consideration and planning;
- Areas of low relief need careful consideration; and
- Further information in relation to culverts under the New England and Golden Highway is required for the detailed assessment of how flows from external catchments interact with the proposed works.

8.6 Construction Considerations and Implications on Design

In areas of low relief along the proposed rail alignment, construction of cess drainage grades of between 0.1 and 0.5 percent are difficult to form. The implication of this on design is the inability for drains to operate as intended. This will be progressed further in the detailed design.

Considerations of construction sediment traps and/or ponds have been excluded from this concept. Confirmation of sediment control requirements will be confirmed during detailed design. If sediment traps/ponds are required, they will likely required additional property acquisition.

8.7 Maintenance Considerations

Maintenance considerations include:

- Impacts on capacity of culverts and other drainage structures such as open channel cess drains as a result of silting and blockage if the system is not maintained;
- Introduction of lobster pots at pit inlets will reduce maintenance of these structures; and
- Stormwater pits may be classified as confined spaces.

8.8 Stakeholder Constraints

The following stakeholders constraints are likely to affect the final design:

- Some augmentation will be required to existing farm dams on private property to tail out existing drainage systems. It has been assumed that this will be acceptable however, community consultation will need to be completed to confirm the concepts; and
- There is a need to maintain existing flow regimes within the catchment and hence diversion of flows away from existing catchments (such as farm dams) is not possible.

Part 3: Level Crossings

9. Hermitage Road Level Crossing

Initial investigations for the Minimbah Bank Third Track project considered the Hermitage Road Level Crossing as part of GHD’s scope. The selection of Option 6 as the preferred track alignment, has moved the limit of works approximately 1km north of the Hermitage Road level crossing, moving it outside the limit of works of the project. Following consultation with ARTC, Hermitage Road was removed from the scope of works for the Minimbah Bank Third Track Project.

Notwithstanding the above, Singleton Council considers it necessary to provide grade separation at the rail crossing on Hermitage Road. It is likely that this level crossing will form part of a separate ARTC project in the future. It is possible however, that due to Singleton Council’s concern regarding Hermitage Road level crossing, upgrading the level crossing may become a condition of approval for Minimbah Bank Third Track. If this is the case, there is a possibility this level crossing will need to be included in the detailed design scope.

10. Private Level Crossing (Ch 231.800km)

10.1 Design Scope and Overview

There is an existing private level crossing at chainage 231.180km, which is currently controlled with passive controls in the form of stop signs. This level crossing serves only one private property. The road that connects the property to the New England Highway is an unsealed private road. The intersection of this private road and the New England Highway is uncontrolled and has a dish drain running along the interface between the two roads.

As part of this project, the New Up main will pass through this level crossing at a different vertical level than the existing tracks. Due to the differing vertical alignment of the proposed and existing tracks it is not possible to keep and upgrade the existing level crossing. Options were considered and a concept developed that looked at closing this level crossing and providing an alternate access for the property via Mudies Creek Underbridge.

Consultation with Singleton Council and the RTA has occurred during the development of the concept. Consultation with the property owner is required for further development of the option, as community consultation has not occurred to date.

10.2 Design Methodology

The following methodology was undertaken to develop the concept for the replacement of the Private Level Crossing at chainage 231.180km:

- An inspection of the level crossing was undertaken to determine current condition, controls, and available route options;
- A desktop assessment was undertaken to determine appropriate treatments and develop possible alternative routes. Note that an Australian Level Crossing Assessment Model (ALCAM) assessment for the level crossing was not available;
- Consultation with the RTA and Singleton Council was required during this phase of the design process to determine their requirements and to incorporate their comments into the proposed concept; and
- Once options were developed a preferred option was selected.

10.3 Existing Level Crossing Condition

The Private level crossing is currently controlled by passive protection in the form of stop signs. The road surface across the level crossing is unsealed and there is a property gate on the southern side of the crossing. Signage is limited for this crossing and is not compliant with AS1742.7.

Through the design development, the Level Crossing Strategy Council was consulted to obtain ALCAM risk outputs. ALCAM is primarily a tool for the prioritisation of level crossing safety improvements, but can be used for the identification and potential mitigation of risks at crossings. The Level Crossing Strategy Council considers a full risk assessment be undertaken especially where new level crossing facilities are being proposed. As this is a private level crossing there were no ALCAM risk outputs available. A risk assessment with ARTC will be completed for this level crossing during detailed design.

10.4 Options Considered in Design Development

Various options for the private level crossing concept were considered taking into account the constraints and current conditions of the site. The various options considered in the design development are discussed below.

10.4.1 Option 1 – Retain and Upgrade Existing Level Crossing

An option was considered that looked to upgrade the existing level crossing to current standards. This option was ruled out once the level difference between the existing rails and the proposed rail was identified. This option was not considered further.

10.4.2 Option 2 – Road Over Rail Bridge

An option was considered to provide a bridge over the rail tracks at the current location of the existing level crossing.

The main issues associated with this option are:

- Limited approach distance required steep vertical grades to clear the rail tracks;
- Large quantities of earthworks would be required to construct the approach embankments for the road;
- Approach embankment could potentially impact on the Nursery adjacent to the existing level crossing;
- The option does not increase safety at the existing intersection of the New England Highway and the Private Road without significant reconfiguration works; and
- Significant capital costs would apply to this option cannot be justified, as the bridge would service one property only.

Due to the significant capital costs that are associated with this option and the availability of a feasible and constructible alternate option, this option was not considered further.

10.4.3 Option 3 – Provide an Alternate Access Underneath Mudies Creek Underbridge

An option was considered that closed the existing level crossing and connected the private property to a new intersection with the New England Highway via a proposed access road underneath Mudies Creek Underbridge. This option would involve providing a new intersection with the New England Highway and a new, predominately unsealed, access road to the property. The access road in the vicinity of Mudies Creek would be sealed on concrete to minimise damage from nuisance flooding.

The main issues associated with this option are:

- A new intersection would be required with the New England Highway, as well as a large section of proposed access track to link the proposed intersection to the private property. The intersection will be simple and utilise as much existing infrastructure as possible;

- Due to the existing Mudies Creek Underbridge there is limited vertical clearance that can be obtained for vehicles. AS5100 specifies that 4.6m vertical clearance is required for road access provided 5.3m clearance is available on an alternate route. 4.6m vertical clearance can be obtained under the existing and new rail underbridge structures, but this may require the provision of an alternate access for the property if over dimensional vehicle access is required. As this is a property access / driveway it may be possible to obtain a wavier to allow a reduced clearance. If a waiver is not granted by ARTC, alternate solutions will be researched and considered;
- Preliminary flooding investigations of Mudies Creek show that if 4.6m clearance were provided underneath Mudies Creek Underbridge, the road surface would be above the 50 year storm event; and
- This alternate access would potentially add an extra 2km onto a trip from the property to Maitland or southbound destinations. There would be no additional trip length for northbound destinations.

10.4.4 Option 4 – Road Under Rail

An option was considered that would provide road access underneath the existing and proposed rails. This road under rail structure would be provided to the south of the existing level crossing, where the track is on a fill embankment.

The main issues associated with this option are:

- While the track is in fill at this location, the road would still need to be excavated underneath the existing ground level some distance so as to provide the required vertical clearance for road access;
- Geotechnical information provided by ARTC indicates the existing material is likely to be very weak silty or sedimentary material creating major stability issues;
- The road would likely be constructed below the water table, and would be prone to flooding. A permanent drainage and pump system would need to be included at the base of the crossing to ensure that any ground water, storm water run-off, or flood event can be pumped clear of the structure. The road would be closed in some flood events;
- The bridge would need to be designed to support the existing rail tracks as well at the third track and the two vehicular access tracks running on both sides of the corridor. A number of possessions would be required to construct this structure, including boring of the foundation elements, and installation of the headstocks and deck units; and
- A new intersection with the New England Highway and connecting roads would be required with this option to connect to the property.

Since this option is considered difficult to construct, and will be very expensive in the long term to maintain, it was not considered further.

10.4.5 Option 5 – Provide Access via Range Road

An option was considered that closed the existing level crossing and provided access to the private property via Range Road. The alignment of the access road to the private property could either be along the proposed rail access track that will run parallel to the down track, or utilise existing property access tracks through adjacent properties.

The main issues associated with this option are:

- This alternate access could potentially add an additional 5km to the journey for the private property owner if they required to travel in a southbound direction;
- It may be undesirable for property access and ARTC maintenance to share a common track. This may force the use of the property access through adjacent properties. There could be safety issues with the private property owner and visitors using the rail access track;
- Additional community consultation and property acquisition impacts as easements for access would be required to be negotiated; and
- If the access road went through adjacent properties it would still need to cross Mudies Creek meaning flooding issues with this and an alternate access or bridge might be required to solve this problem.

Due to there key issues, this option was not considered further.

10.4.6 Option 6 – Provide Access via Golden Highway

Similar to option 5, an option was considered that closed the existing level crossing and provides an alternate access for the private property via the Golden Highway. The alignment of the access road to the private property would be from the Golden Highway via adjacent properties to the south of the level crossing. This would involve creating new access tracks as initial investigations indicate there is no adequate access currently present in this location.

The main issues associated with this option are:

- This alternate access could potentially add an additional 5km to the journey for the private property owner if they required to travel in the northbound direction;
- Initial investigations indicate that there is currently no adequate property access track that currently runs through adjacent properties. This would mean that a large length of new access road would be required; and
- Additional community consultation and property acquisition impacts are required, as easements for access would be required to be negotiated.

Due to the large potential increase in travel distance, the additional issues associated with property acquisition, and the availability of an alternate option that has a reduced impact on the property owner, this option was not considered further.

10.4.7 Recommendation

Based on the above summation of the options considered, a general overview of the capital costs, and consideration of the requirements of the property owner, the preferred option chosen for the concept stage of the project was Option 3, which provides an alternate access underneath Mudies Creek Underbridge. Community consultation with the relevant property owners is required before further development of this option continues. If this alternate access is not possible, other solutions will be considered in detailed design.

10.5 Design Parameters

The design parameters for the private level crossing concept are:

- The level difference between the proposed rails and the existing rails at the existing level crossing makes it not possible to retain;
- The land around the existing level crossing is flood prone, which restricts the excavation depth underneath Mudies Creek; and
- Vertical Clearance underneath Mudies Creek underbridge. AS5100 specifies that 4.6m clearance is required as long as there is an available alternate route with 5.3m clearance.

10.6 Road Concept Design

This section of the report details the concept design of the preferred option for the Private Level Crossing at chainage 231.180km.

For this stage of the Minimbah Bank Third Track Project, the Private Level Crossing concept was not modelled using road design software. However, investigations were completed into the road cross-section, intersection arrangements of the proposed intersection with the New England Highway, and flooding levels through Mudies Creek.

10.6.1 Preferred Option Description

The preferred option for this concept is to close the existing level crossing and provide an alternate access under Mudies Creek Underbridge.

A new intersection will be provided between the New England Highway and the proposed access road. The access road will connect the New England Highway with the private property on an alignment that runs beneath Mudies Creek Underbridge, and then runs parallel to the rail line on the southern side to the private property.

10.6.2 Horizontal and Vertical Alignment

The horizontal and vertical alignments for this access road will be modelled in the detailed design stage. The vertical alignment will essentially using the existing surface level.

In the vicinity of the intersection with the New England Highway, the vertical alignment will be in fill to connect the existing surface level to the level of the highway with an appropriate grade. Details of the vertical alignment are to be determined once modelling of the access road and intersection has been completed. This is part of the detailed design.

10.6.3 Intersection with the New England Highway

For the intersection of the New England Highway and the proposed access road, the minimum treatment will be provided. This allows for BAR (basic right turn treatment) and BAL (basic left turn treatment). This treatment provides sufficient trafficable width for a heavy vehicle to pass a single stationary vehicle.

Details of the intersection arrangement are to be designed once modelling of the intersection have been completed. Street lighting requirements at this intersection are also to be determined with further consultation with the RTA.

10.6.4 Pavement and Earthworks

The access road to the private property will be primarily unsealed, except for in the vicinity of Mudies Creek and on direct approach to the proposed intersection with the New England Highway. Details of pavement will be determined following geotechnical investigation.

Beneath Mudies Creek Underbridge it is assumed that the access road will be concrete to reduce the required maintenance caused by flooding of Mudies Creek above the estimated 50-year storm event.

On approach to the proposed intersection with the New England Highway, the access road will be sealed to tie into the highway. Details on the length of seal from the highway are to be determined during detailed design.

It is envisaged that there will be minimum earthworks involved with the Private Level Crossing design. Fill will be required to connect the level of the New England Highway to the existing surface level between the rail and the highway. The remainder of the access road is assumed to be near the natural surface level and as such will involve minor earthworks.

10.6.5 Drainage and Flooding Levels

Investigations were completed into the flooding levels of Mudies Creek to determine maximum storm events for the access road. Using an idealised channel shape underneath Mudies Creek Underbridge, the 50-year storm event came up to an RL of 31.5m, which provides a clearance of 4.7m to the soffit of the bridge girder. This is sufficient clearance for this area.

Further investigations are required into the drainage between the tracks and the New England Highway to the east of Mudies Creek, as it is possible that the access road could cut off flows to Mudies Creek. These investigations will be completed during detailed design once the proposed access road has been modelled.

10.6.6 Construction Issues

There will be minor construction issues involved with the alternate access under Mudies Creek Underbridge. These include:

- Traffic control required at proposed intersection works; and
- Limited height clearances when working underneath Mudies Creek Under Bridge.

10.6.7 Maintenance Issues

The only maintenance issue involved with the concept is in regards to who would be responsible for the maintenance of the access track. This is unknown at this stage, and will be confirmed following community consultation with the property owner.

11. Range Road (Ch 233.958km)

Range Road level crossing, located at chainage 233.958km is recommended to be upgraded to a grade separation. Discussion on this element of this project, as well as justification of the grade separation is detailed in Part 4, Section 16.

Part 4: Bridges

12. Golden Highway Overbridge

12.1 Design Scope and Overview

The Golden Highway is a sub arterial road that links the Hunter Valley and Dubbo. It provides a critical link to the Mount Thorley industrial area, the Singleton Military Base and various mines in the Hunter Valley.

The Golden Highway crosses the Main North rail corridor within the limits of work at an existing bridge approximately 15km south of Singleton. The existing bridge is a three-span steel girder bridge, and is in very poor condition with significant corrosion and damage at abutments and deck joints. The bridge currently provides 4.7m vertical clearance above the existing rails to the soffit of the bridge girders. As directed by the ARTC, the structural clearance envelope over the existing and new tracks is to provide 5.1 m minimum clearance from the top of rail. The existing bridge is therefore non-conforming to the requirements specified by the ARTC.

Due to the current condition of the existing bridge, the required structural clearances, the additional length of bridge required to span the proposed third track, and the requirement to minimise construction impacts on the existing rail traffic, a new bridge is required on the Golden Highway to span across the Main North Rail Lines. This section of the report details the concept design process and output for the Golden Highway road design and the Golden Highway bridge structure.

Additional survey is required to the west of the Golden Highway Bridge, to tie into the existing alignment. Vertical alignment tie-in for concept design is based on an extension of the existing vertical grade. Horizontal alignment tie-in for the design is based on centreline points taken from aerial photography. Additional survey of this area will form part of the detailed design. The western connection to the existing alignment will be confirmed following detailed survey.

12.2 Design Methodology

The Concept Design of the Golden Highway road and bridge structure was progressed in unison with the concept design of the proposed third track by applying the following methodology:

- A desktop study and site visit was undertaken to review the existing traffic volumes, current conditions of the bridge and road, to determine the constraints applicable to the design and to identify the surrounding land uses;
- Site constraints affecting the concept design development were assessed;
- Alignments were developed for the Golden Highway that included keeping the existing horizontal alignment and several alternate alignment options;
- Upon completion of the alignment options, the existing alignment option and an alternate alignment option were developed so that cost comparisons could be made between them;
- The two options were tabled with the RTA to canvas their requirement. The RTA gave clear preference to an alternate alignment at this location so as to minimise construction impacts and closures of the Golden Highway; and
- The preferred option was selected taking into account ARTC requirements, RTA preferences and the cost comparisons, then documented for the concept stage.

12.3 Design Parameters

12.3.1 Design Criteria

The options and the final concept design for the Golden Highway road and new bridge structure were developed based on the standard design criteria detailed in the Design Criteria Report, which is included in Appendix B.

A summary of the main criteria and client preferences considered in the development of these options are noted below:

- 5.1 m minimum vertical clearance for the Structure Gauge 1994 kinematic envelope above the top of rail. This is a modified vertical clearance envelope in accordance with BDS 12, Section 4 and does not allow for double stacking containers as agreed to by ARTC;
- ARTC preference for no piers within the rail corridor;
- ARTC preference for a bridge style crossing versus other style of structure;
- Specific bridge design limitations as detailed in Section 13.4.1;
- Maintain or improve the road design speed;
- Minimise capital costs;
- Minimise the quantity of property acquisition and property severance required; and
- Minimise requirements for rail track possessions and therefore minimise the impact on the existing rail traffic.

12.3.2 Bridge Arrangement Requirements and Constraints

The style of bridge structure required at this location was chosen to be of simple construction so as to decrease construction time, reduce track possessions and impacts on existing rail traffic, and be cost effective. Based on these requirements the style of structure to be adopted, and the limitations or constraints on the road design have been listed below:

- The bridge superstructure to be adopted is to be prestressed precast T-Roff bridge girders with a composite concrete deck. These style of bridge girders allow for large spans while simplifying construction, with no requirements for onsite formwork over the rail corridor;
- Spans are limited to approximately 35 m. Single span bridges will require less construction activity within the rail corridor and minimise rail track possessions;
- Skew angles are limited to approximately 35 degrees;
- Horizontal curve radius on the bridge deck must be minimised to allow for the curve within the top flange of the T-Roff girder only. That is, the top flange is to be either concave or convex to match the radius of the road alignment;
- Vertical curves on the bridge deck should be minimised and vertical sag curves should be avoided; and
- One way cross fall on the bridge deck can be provided, however super transition should be avoided to minimise deck thickness variations across the bridge.

Other advantages in the style of construction at this location are:

- Simple reinforced earth wall abutments are a cheaper style abutment wall but can only be considered where adequate room for excavation and construction of the soil block can be allowed for.

12.4 Options Considered in Design Development

Options considered in design development are illustrated in Figure 19.

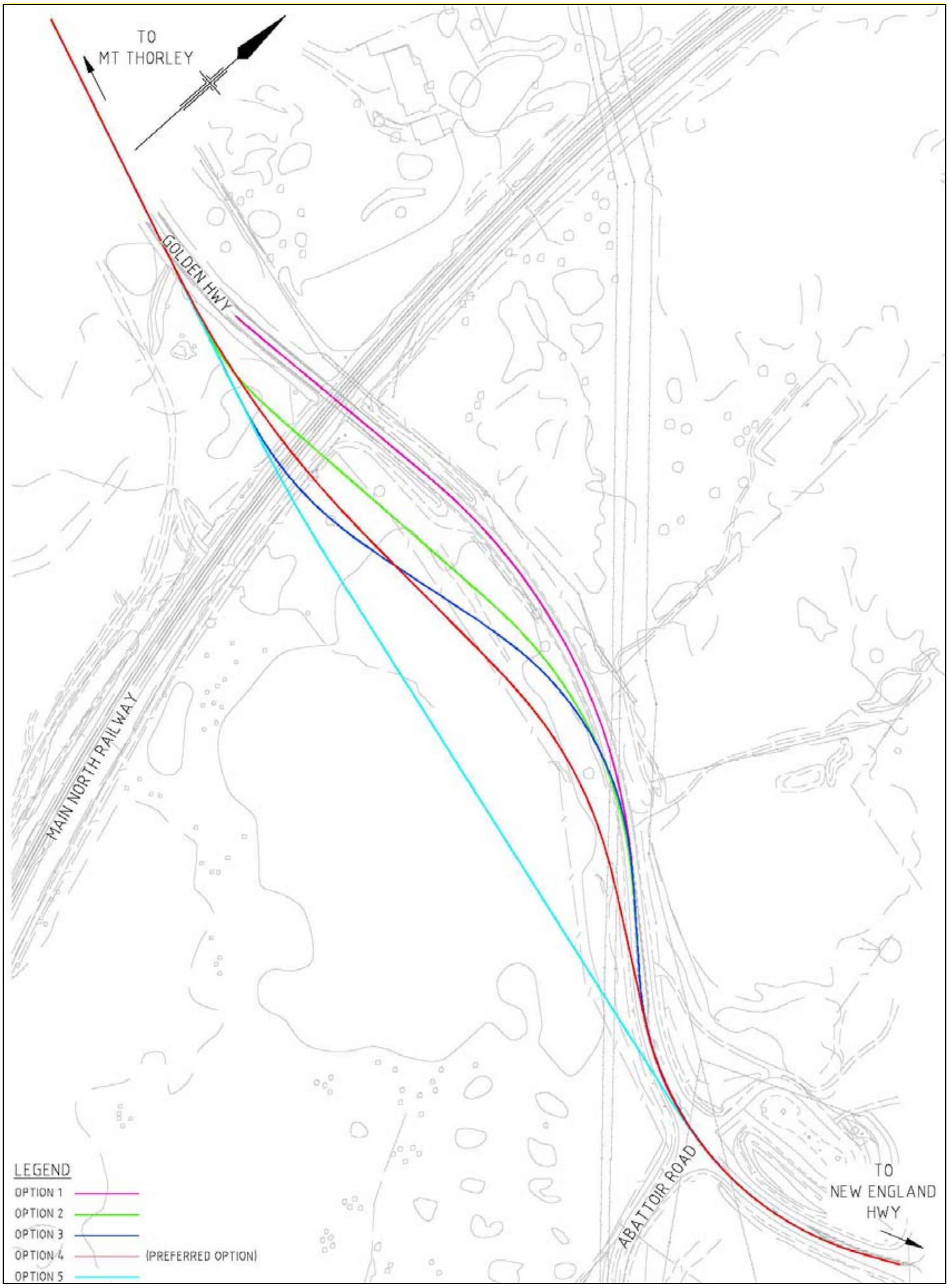

Figure 19 Golden Highway Alignment Options

12.4.1 Option 1 - Existing Alignment Option

As part of the options development for the Golden Highway concept design, an option for replacing the existing bridge and road on the same horizontal alignment was considered at the request of ARTC. The initial perceived benefits considered to be available by pursuing this option included lower capital costs, lower risks to the ARTC, lower ongoing maintenance costs and potential liabilities associated with upgrading an existing road rather then building a completely new road, and a smaller area of land acquisition required to construct the road. However, after all the issues were accumulated for this option, it was determined that an alternate alignment option was not only preferred but more economical in terms of capital cost.

The main issues associated with this option are as follows:

- As the existing bridge is non-conforming to the concept design criteria, the new bridge would have to be constructed substantially higher then the existing levels at the bridge location. As such, the potential cost savings due to the smaller extent of new earthworks and pavement on the highway were not apparent;
- To minimise the extent of new earthworks and pavement, the structural depth of the bridge was minimised by including an intermediate pier within the rail corridor. This increased the complexity of construction and the number of possessions required during construction;
- Closing of the Golden Highway for any extended period of time would not be feasible (as confirmed by RTA), so the bridge foundations and abutment walls would need to be constructed under traffic, and during night works. This form of construction is significantly more expensive than greenfield construction practices;
- Demolition and removal of the existing bridge, construction of the intermediate pier within the rail corridor, as well as placing the deck girders would need to be completed under track possessions hence impacting on the existing rail traffic. There would be significant risks to the construction program and cost relating to these items if they cannot be completed within their allotted possessions;
- The structural form of the abutment walls would require contiguous piles instead of reinforced soil walls due to the constructability of the bridge, making these elements significantly more expensive;
- There would be significant costs associated with closing the Golden Highway and providing a suitable detour that would function the same as the Golden Highway while providing access for B-Doubles and over dimensional vehicles. Significant costs would be expended to upgrade Range Road if this were to be used as a detour route. There would also be the potential for significant queuing on the New England Highway at the existing level crossing if an upgrade were not completed prior to closing the Golden Highway. The RTA has advised that over dimensional vehicles could not travel through Singleton town centre, and it would be difficult to find an alternate route for these vehicles; and
- The RTA considers that it is unlikely that Singleton Council and the community would agree to the Golden Highway being closed for the required 6 – 8 weeks for construction.

12.4.2 Option 2 - New Alignment – 70km/hr As Close to the Existing Bridge As Possible

An option was considered that essentially runs parallel to the existing Golden Highway alignment and allows the bridge over the rail tracks to be built off-line. This option positioned the proposed bridge as closed as possible to the existing bridge considering constructability and design, whilst also minimising the length of new road construction required. The benefits available from adopting this option included smaller extent of earthworks and pavement, a smaller area of land acquisition compared with other options, a simple bridge arrangement perpendicular to the existing rail alignment, and the ability to construct the new road and bridge separate to the existing highway alignment.

The main issues associated with this option included:

- The design speed of 70km/hr due to the required radii was considered too low. While being consistent with the current area of Golden Highway in the vicinity of the existing bridge, this design speed is not consistent with the rest of the Golden Highway and the future vision for the road; and
- The road design also requires significant extents of super elevation transition across the bridge deck, which is undesirable from a bridge design perspective.

12.4.3 Option 3 - New Alignment – 70km/hr Back-to-Back Curves

An option was considered that was a revision of the previous 70km/hr option. The option looked at using back-to-back curves providing a constant horizontal radius on the bridge deck. This option requires the new bridge to be constructed further away from the existing bridge than the previous option, but tie back into the Golden Highway eastern approach at a similar location. The benefits available from adopting this option include similar earthworks and pavement extents to Option 2, a workable bridge arrangement within the limitations set-out above, and the ability to construct the new road and bridge separate to the existing highway alignment.

The main issues associated with this option include:

- The design speed of 70km/hr due to the required radii was considered too low. While being consistent with the current area of Golden Highway in the vicinity of the existing bridge, it is not consistent with the rest of the Golden Highway and the future vision for the road;
- The road design contained substandard straights between curves, and a tight transition of super elevation between curves. This is considered to be a potentially uncomfortable drive and may not pass a road safety audit;
- Although the road alignment allows for a constant radius across the bridge deck, the required super elevation transition between the curves still impacts on the bridge deck and is deemed not acceptable; and
- The quantity of land acquisition is greater then the Options 1 and 2.

12.4.4 Option 4 - New Alignment – 80km/hr preferred option

An option was considered increasing the design speed to 80km/hr which is the RTA's preferred sign-posted speed of the road at this location. The road design was developed using standard curves, straights, and transitions to connect the new alignment to the existing Golden Highway. The benefits of this option include a road design complying with the requirements of the Road Design Guide, a higher design speed considered to be inline with the rest of the Golden Highway, a bridge arrangement on a single constant radius curve with no super transition within the bridge deck, an area of land acquisition of a similar magnitude to the previous option, and the ability to construct the new road and bridge separate to the existing highway alignment.

The main issues associated with this option include:

- The road design required a slightly longer length of new road therefore increasing the quantities of earthworks and pavement; and
- The bridge design included a slight skew angle within the bridge deck, but was well within the limitations of the T-Roff style bridge girders. This also increases the overall length of the bridge compared with the previous options.

12.4.5 Option 5 - New Alignment – 100km/hr

An option was considered increasing the road design speed in the vicinity of the existing bridge crossing to 100km/hr. This option required large radius curves as well as a much larger overall footprint to fit this design into the constraints. The option essentially provided a straight alignment between the eastern approach at the Abattoir Road intersection, across the rail corridor and a slight single curve to connect back into the Golden Highway west of the rail corridor. The benefits of this option included an increased road design speed as well as minimising the number of curves in the road alignment, and the ability to construct the new road and bridge separate to the existing highway alignment.

The main issues associated with this option include:

- Due to the significantly longer length of road required for this option, the capital costs relating to earthworks and pavement quantities are also significantly higher;
- The extent of works required at the Abattoir Road intersection is unknown, and is required for this option, but not for any of the other options;
- The higher design speed would encourage a faster approach speed to the intersection of the New England Highway and the Golden Highway. This would not be preferred from a Road Safety audit point of view since the existing intersection is already considered a black spot;
- It requires a significantly larger area of property acquisition compared with any of the other options; and
- The bridge design will include a much higher skew angle within the bridge, and therefore a longer bridge deck than any of the other options.

12.4.6 Recommendation

Based on the above design development, capital cost implications, and discussions with the relevant authorities including the RTA, Singleton Council and the ARTC, the preferred option chosen to be developed as part of the final concept design was Option 4, a new alignment with a design speed of 80km/hr.

12.5 Road Concept Design

12.5.1 Preferred Option Description

The preferred option of the Golden Highway road alignment is Option 4, which provides a new alignment of the Golden Highway, and a new bridge over the Main North Railway to the south of the existing bridge. The new Golden Highway alignment has been designed for an 80km/hr design speed, and involves approximately 640m of new pavement.

The new alignment has been designed to the RTA's Road Design Guide (RDG).

The Golden Highway concept design will need to be slightly amended during the detailed design stage to begin the horizontal curve earlier before the bridge. This will mean a slight change to the alignment, but will allow the complete development of superelevation before the start of the bridge and allow full superelevation to extend across the complete bridge structure. This will allows for an easier bridge design and construction.

12.5.2 Non Conformances

It is noted that standard RTA lane widening has not been provided for in the Golden Highway concept design. This non-conformance only applies to the 240m radius horizontal curve between approximate chainages 340 to 420, and is to be amended at detailed design. Lane widening is not required for the first curve, as the width provided in the concept design has been used to tie into the existing Golden Highway cross section.

12.5.3 Horizontal and Vertical Alignment

The vertical and horizontal alignment for the Golden Highway is based on an 80km/hr design speed.

Two horizontal curves have been used to link the Golden Highway to the new bridge structure. It is noted that the radius of the existing curve approaching the New England Highway is lower than the requirement for an 80km/hr design speed in the RDG.

A single vertical curve has been used to tie-in with a straight extension of the existing surface of the Golden Highway to the west of the bridge. The maximum grade used in the design is 6.07%, which is in accordance with the RTA RDG.

The vertical alignment has been designed so that the crest of the curve is to the east of the bridge. This allows the development of the required clearance over the rails and minimises the extent of works on the western side.

12.5.4 Cross Section

The cross section of the new alignment of the Golden Highway is as follows:

- A 3.5 m through lane has been provided in both directions;
- 3 m shoulders have been provided adjacent to guardrails to allow a car to safely pull over;
- Where guardrails have not been provided the shoulder is 2m which also accounts for cyclist; and
- A 1.0m verge has been provided between the trafficable face of the guardrails and the top of the fill embankment.

In accordance with the RTA RDG, except for the required lane widening as specified in Section 13.5.2.

12.5.5 Crossfall and Super Elevation

3.0% crossfall has been provided for sections of straight horizontal alignments on the Golden Highway. Through horizontal curves, the crossfall transitions to 7% superelevation except for the horizontal curve across the bridge, where due to the large radius 5% superelevation was adopted as specified in the RDG.

12.5.6 Batters

2(H) : 1(V) batter slopes have been adopted for the Golden Highway concept design.

12.5.7 Guardrails and Barriers

Where the Golden Highway is in fill and batter slopes are 2:1, W-Beam guardrails have been provided. In the vicinity of the bridge, these transition to Thrie Beams to interface with the rigid bridge barriers. Standard RTA transitions, MELTS, and Trailing Terminals are to be used for the guardrails. Type of guardrail to be confirmed with the RTA at detailed design stage.

Across the bridge type MAO (medium performance level) bridge traffic barriers are to be provided.

12.5.8 Pavement and Earthworks

The pavement design for the Golden Highway is to be completed as part of the geotechnical investigations as part of the detailed design. For quantity purposes, a previously used pavement design on the Golden Highway was adopted. The pavement design is to be confirmed following geotechnical investigations and incorporated into the detailed design.

Due to the additional clearance above the rail and the new alignment of the road, the new alignment of the Golden Highway is in substantial fill. This has been included in the over the project earthworks balance. Where possible the fill material will be coming from other areas of the project.

12.5.9 Pavement Drainage and Cross Drainage

Drainage flows on the new alignment of the Golden Highway are to be captured by the rail cess drains. Where the road is in fill, the crossfall will direct flows off the road. Depending on which side of the road it’s on, drainage will either be directed to the culvert located at chainage 228.648km or be channelled between the proposed Golden Highway batter and the existing highway batter to be captured in the rail cess drain.

Where the road is in cut, dish drains have been used to capture flows for discharge to appropriate locations that can be directed an appropriate outlet.

Drainage for the Golden Highway will be progressed further during detailed design.

12.5.10 Construction Issues

Road construction issues will consist of minor issues with constructing the connection to the existing Golden Highway. A Traffic Management Plan will be required to minimise interruptions to Golden Highway traffic during construction. The majority of the road works are separated from the existing road reserve and therefore pose minimal issues.

12.5.11 Interface with Bridge Design

The interface of the road surface and the bridge structure is to be detailed at detailed design stage.

12.6 Bridge Concept Design

12.6.1 Design Loads and Criteria

The Golden Highway Bridge was designed based on:

- The horizontal and vertical road alignments determined based on Option 4 is an 80km/hr design speed on an alternate alignment;
- The Design Criteria for road bridges on highways stipulated in the Design Criteria Report;
- Preliminary aerial survey and detailed survey at the existing bridge crossing. Minimal survey of the existing road was available during this stage of the project, and any deficiencies in the design will be determined once adequate survey has been received during the detailed design of the project;
- Minimal geotechnical information. A geotechnical desktop study and a walk through was completed as part of the concept design. No geotechnical investigations or testing have been completed in this stage of the project, therefore any inferred rock levels or strengths have been assumed and are liable to change during the detailed design phase of the project; and
- The bridge deck width has been determined based on the lane and shoulder width requirements within the RTA RDG.

12.6.2 Bridge Design and Arrangement

The concept design of the Golden Highway Bridge is a 31.5 m single-span prestressed precast T-Roff girder bridge on a 12 degree skew. Six 1.8 m deep T-Roff girders have been adopted to support the bridge deck which consists of a 160 mm minimum deck slab and a 65 mm asphaltic wearing course. The superstructure will be supported on laminated elastomeric bearings at each abutment location, and restrained from lateral loadings using an anti-sliding block incorporated into the design of the abutment headstock. The bridge deck width has been sized to allow for two 3.5 m lanes in each direction, along with a 3.0 m shoulder adjacent to these lanes. The bridge safety barriers adopted are 1.3 m high medium level traffic barriers, consisting of an insitu slip formed concrete parapet with a two-rail barrier fixed to the top of the parapet. The 3.0 m shoulder and the 1.3m high barrier have been adopted to allow for cyclists across the bridge structure. The road alignment at the bridge location is on a constant 600 m radius along the length of the bridge deck which will be taken up in the top flanges of the edge girders. The barriers will follow this alignment to have a smooth transition from the off structure barriers onto the bridge. The bridge deck will have a 5% one-way cross fall along the length of the bridge, and a longitudinal fall of approximately 5% along the length of the bridge.

The bridge superstructure is supported on bored pile abutments. The bored pile abutments are restrained at their head by the use of dead man anchors, which use passive soil pressures to limit the movement of the pile head. The abutment embankments are a mixture of cut and fill embankments. The construction technique to be adopted for these embankment walls comprises reinforced soil walls (RSW), and will require initial excavation into the natural surface to allow adequate room for the reinforced soil block. The RSW abutments allow for a vertical face adjacent to the rail corridor, therefore minimising the required span of the bridge. The face of the RSW walls is to be constructed from precast panels. The RSW abutment walls also act as a protection barrier to the bridge supporting elements so that train impact loads do not affect the main supporting members. The location of the abutment walls were chosen to be outside the access tracks on both sides of the corridor, and to allow the longitudinal cess drainage to be continuous through the structure.

The transition from the bridge to the road embankment is through the adoption of a 6 m long approach slab at each abutment. The approach slab will manage the differential settlement between the road and the bridge deck providing a smooth crossing.

12.6.3 Construction Issues

The new bridge structure is to be constructed south of the existing bridge. Since the bridge is separated from the existing road there will be minimal traffic impacts on the construction of the bridge. The arrangement of the bridge has also been determined to minimise impact on the existing rail traffic. This has been achieved by limiting the bridge to a single span and therefore removing the need for internal piers, and also by locating the supporting abutment and the abutment walls outside the danger zone of the existing tracks.

The abutments will need to be constructed under rail traffic control but will not need any possessions to construct any of the elements. This includes the bored piles; the reinforced soil wall abutments, the abutment headstock beam and the dead man anchors.

A short track possession will be required to place the T-Roff girders onto the supporting abutments. This operation will involve craning the precast girders into place and providing temporary support prior to the deck slab being poured. No temporary formwork will be required on the bridge deck for the any of the other operations, and temporary access and fall protection will be provided on the deck structure during construction.

The existing water main currently supported on the existing Golden Highway Bridge is required to be relocated and supported off the barriers of the new bridge. Installation of this water main and supporting structure will require control of the rail traffic below.

The existing bridge will be decommissioned once traffic has been switched to the new road alignment. The existing bridge will therefore need to be demolished and removed from site prior to completion of the project. The timing of this activity will not affect the overall construction program, but will need to be completed during a track possession.

13. Mudies Creek Underbridge

13.1 Design Scope and Overview

Mudies Creek is a tributary of the Hunter River and is affected by flooding caused by backwater flood events within the Hunter River. Mudies Creek passes underneath the existing rail corridor at approximate chainage 232.220km, and continues east underneath the New England Highway.

The existing Mudies Creek bridge currently supports both the Up and Down main lines. The existing bridge is a 4 span prestressed rail plank girder bridge supported on intermediate piers with access walkways on both side of the tracks. The existing bridge replaced a steel truss and brick pier and abutment bridge in the mid 1990’s and is in good condition.

The proposed third track is to be a new Up main track and will be constructed on the eastern side of the existing tracks. An additional bridge structure is required to support the proposed third track adjacent to the existing bridge structure. To minimise construction impacts on the existing rail traffic and to simplify the construction of the new structure, the new structure will be offset from the existing structure. The proposed third track is therefore aligned to provide a separation of the existing Up track and the New Up main track of 8.7 m. The new structure is centred underneath the new third track design alignment.

The private level crossing at chainage 231.800km as discussed above in Section 10 will be closed as part of this project. To provide alternative access to this property it is proposed to use the Mudies Creek Bridge crossing location to allow access to this private property underneath the rail corridor. Adequate clearance underneath the existing and new structures will be provided to suit the requirement for this alternate access (subject to acceptance of the 4.6m clearance proposal).

This section of the report details the design process and output for the concept design of the Mudies Creek Bridge.

13.2 Design Methodology

The concept design of the Mudies Creek Bridge was progressed in unison with the concept design of the proposed third track by applying the following methodology:

- A desktop study and site visit was undertaken to review current conditions of the existing bridge, determine the constraints applicable to the design, and to identify the surrounding land uses;
- Site constraints affecting the concept design development were assessed;
- Structural clearance requirements were developed to determine the required offset of the proposed third track at the bridge location, so as to progress the rail design at this location;
- After the preferred offset was determined and the rail vertical and horizontal alignment were set, the structural bridge concept was progressed in accordance with the Design Criteria Report; and
- The bridge concept design was documented for the concept stage.

13.3 Design Parameters

The concept design for the Mudies Creek Bridge was developed based on the standard design criteria detailed in the Design Criteria Report, which is detailed in Appendix B.

The main criteria and client preferences considered in the development of these options are noted below:

- A 2.5 m horizontal clearance to any fixed items for the Structure Gauge 1994 kinematic envelope was adopted;
- 4.6 m vertical clearance envelope for the private access road to be constructed underneath the existing and proposed bridges;
- To minimise impacts on the existing floodway area, the new bridge will match the existing bridge in terms of span lengths and structural form. Detailed flood analysis of the area was not completed as part of the concept stage, and flood levels and requirements will be reviewed during the detailed design stage of the project;
- The bridge superstructure will be designed with flood immunity under serviceability load cases to the 1:100 year ARI, and in the ultimate load cases to the 1:2000 year flood event;
- Minimise capital costs, including earthworks, pavement, and bridge costs;
- Minimise the quantity of property acquisition and property severance required; and
- Minimise requirements for rail track possessions and therefore minimise the impact on the existing rail traffic.

13.4 Concept Design Development

The concept design of the proposed bridge structure was developed using the information available at the start of the concept design stage. Information available relating directly to the existing Mudies Creek Bridge included:

- Detailed Design Drawings for the Existing Bridge;
- Geotechnical Investigation Report at the site completed prior to the construction of the existing bridge;
- Flood study results at the bridge location only;
- Detailed bridge survey completed during the Concept Design stage; and
- Aerial survey of the rail corridor.

The following is a description of the information considered and the design development completed based on this information.

13.4.1 Hydrological and Flood Impacts on Concept Design

The existing bridge was upgraded in the 1990's and as part of this upgrade, a flood study was completed to determine actual and calculated flood levels at the bridge crossing location. The results of this study were available during the Concept Design of the project. Workings or calculations were not available.

The results of the flood study determined areas of inundation upstream of the existing bridge structure as well as specific flood levels for the various storm events. Following is a summary of the various flood levels determined during this previous flood study:

- Calculated 1:100 year local flood level = RL 32.7 m;
- Calculated 1:2000 year local flood level = RL 33.7 m; and
- 1955 Flood Level (with back water effect from the Hunter River) = RL 36.2 m.

Previous flood study appears to have considered the catchment contributing to Mudies Creek only in the establishment of the 100 and 2000 yr flood levels. Given the location of this bridge in relation to the Singleton flood plain, there is likely to be a seasonable interaction with flood levels from the Hunter River. This may account for the variation between the historical flood levels of the 1955 and 2007 storm events and the design flood levels shown on the Mudies Creek design drawings.

The soffit of the existing bridge deck is at approximately RL 36.2 m so in the case of the 1955 and the 2007 floods, the superstructure of the bridge was impacted by flood loading. As a result of this observation, the concept design of the new bridge structure has been developed considering increased lateral loads on the superstructure, higher lateral loads on the intermediate piers, and the requirement for hold down restraints of the deck is noted to account for uplift forces that may develop. The soffit of the new bridge structure has also been limited to be at the same level or higher than the existing bridge structure.

The low flow storm events through this structure may have a potential scouring effect on the subgrade, specifically around the intermediate pier columns. The existing bridge structure has incorporated a large gabion mattress into the middle two spans of the structure to limit any potential scour in these zones. The new bridge will also adopt a similar treatment to minimise scour and erosion due to smaller storm events.

13.4.2 Geotechnical Implications on the Concept Design

The existing bridge was designed based on a site specific geotechnical investigation report which detailed the quality of the overlaying material, the depth and quality of the bedrock, as well as the extent of the existing brick foundations related to the previous bridge structure at this location. This information was particularly useful in determining the style and extent of foundation treatments to be adopted at this location.

The material properties and depth of the existing bedrock documented in the previous investigation was:

- Class II Slightly Weathered Shale Bedrock;
- Ultimate Strength Parameters = 10 MPa (End Bearing) and 1 MPa (Shaft Adhesion); and
- Bedrock founded at RL 22.4 m.

The concept design of the new bridge structure over Mudies Creek was developed based on the above information. Detailed geotechnical investigations will be completed prior to the detailed design phase of the project and the above parameters and geotechnical information will be checked at that stage.

13.4.3 Rail Offset Calculations for Concept Design

The existing information relating to survey and reduced levels at the site were adequate to progress the concept design. The information available included:

- Aerial survey of the rail corridor;
- Detailed bridge survey completed during the Concept Design Phase;
- Detailed Design Drawings for the Existing Bridge; and
- Detailed Design levels for the proposed third track completed using terrain modelling software (MX).

To determine the required offset of the proposed third rail, the structural form of the bridge had to be determined to confirm that adequate room was available both to construct the bridge as well as to provide adequate clearance for operational and maintenance purposes. The existing bridge was adopted as a first pass structural form, since the existing bridge is in good condition, has performed its duty for a number of years, is of a standard rail construction type and is easily maintainable.

The offset of the proposed New Up main was calculated taking into consideration a number of items. These include:

- Construction sequence, construction clearances, temporary barriers and support during construction;
- Track clearance requirements on the new structure based on Structural Gauge 1994;
- Adequate offset between the bored pile foundation elements to allow the new bridge to minimise the impact on the existing bridge structure;
- Maintenance access walkway requirements along the side of the new bridge; and
- Access track requirements, assuming the access tracks on the Up and Down sides of the track will not be required to be carried by the new bridge or any other structure at these locations.

Based on the review of these issues, and the consideration of construction implications at the site, a preferred offset of 8.7 m between the centreline of the existing Up track and the centreline of the proposed New Up main was determined. This allowed construction of the new bridge structure to be completed with minimal impacts or modifications being required to the existing structure. The abutment walls will be the only item requiring modification to suit the new bridge structure, which can be completed with minimal impact on the existing rail traffic.

13.4.4 Private Level Crossing Alternate Access

The private level crossing at chainage 231.800km as discussed in Section 10 will be closed as part of this project.

To provide alternative access to this property it is proposed to use the Mudies Creek bridge crossing location to allow access to this private property underneath the rail corridor. A minimum agreed clearance underneath the existing and new structures will be provided to suit the requirement for this alternative access.

The concept design of the proposed bridge considered the existing levels of the existing bridge and the ground levels on the southern side of the bridge structure to confirm if it was feasible to allow for adequate clearance under the two structures for this access. A vertical clearance of 4.6 m minimum is required to be achieved at this location to satisfy the requirements of AS5100 in conjunction with a primary alternate 5.3m access. The existing bridge has approximately 4.0 m vertical clearance at the southern most span, so it is considered feasible to modify the existing levels to suit the required clearances with minimal impacts on the existing bridge or the new bridge concept design.

The flood immunity of this alternate access is discussed further in Section 10.

13.5 Bridge Concept Design

13.5.1 Design Loads and Criteria

The Mudies Creek Bridge was designed based on:

- The horizontal and vertical rail alignments determined in the concept rail and earthworks design;
- A preferred offset of the proposed third track from the existing Up main of approximately 8.7m;
- The Design Criteria for rail bridges as stipulated Design Criteria Report. Refer to Appendix B for reference to this report;
- Preliminary aerial survey and detailed survey at the existing bridge crossing. Detailed survey of the entire rail corridor will be completed prior to progressing the detail design;
- Preliminary geotechnical information only. Based on previous investigations at the site, there was enough geotechnical information available to progress the concept design. Confirmation of this geotechnical information will be required during the detailed design phase; and
- The bridge deck width has been determined based on the clearance requirements for the proposed third track based on Structure Gauge 1994.

13.5.2 Bridge Design and Arrangement

The concept design of the Mudies Creek Bridge is a 4 span, prestressed precast voided rail girder ballasted top bridge parallel to the existing Mudies Creek Bridge. The span lengths are approximately 13.1 m on the end spans and 12.0 m on the internal spans. All of the spans are simply supported with direct support onto the intermediate piers and abutments via elastomeric bearings. Hold down restraint at each of the bearing supports will be provided to resist uplift forces on the deck during flood events. Eight 950 mm deep prestressed rail girders have been adopted to support the proposed third track and ballast profile, providing an overall width of deck of approximately 5.7 m. The deck has been restrained laterally to the substructure using up-stand corbels at the edges of the pier headstocks and abutments. This provides restraint against loading such as train nosing loads, earthquake loads, and lateral flood loads. Upstand walls have been incorporated into the deck of the bridge to retain the ballast formation over the length of the bridge as well as providing support to the access walkways on both side of the track. The bridge deck has been designed to be level with adequate drainage provided through the Upstand walls to remove water during storm events.

The bridge sub structure consists of three internal piers and two abutment headstocks. All of these elements are supported directly on bored piles and formed columns to the underside of the headstock beams. The bored piles are bored and socketed into bedrock at a depth of approximately 15 m below the top of rail levels on the proposed third track. The abutment piles are restrained at their head by the use of dead man anchors which use passive soil pressures to limit the movement of the pile head.

The existing bridge abutment walls are gravity retaining walls constructed using brick construction. The new bridge abutment walls will be required to join directly to the new abutment walls in order to retain the new embankment. The concept design has allowed for a mix of gravity wall and cantilever wall to join directly to the existing abutment wall. The new abutment wall will be faced with brick facing to match the existing abutment walls. The foundations of the new abutment wall includes a downturn in the supporting footing to prevent scouring of the abutment walls.

A ballast box approach slab has been incorporated into the concept design so as to retain the ballast formation at the approach to the bridge, and to minimise direct lateral loading due to the surcharge of the trains on the back face of the abutment headstocks.

13.5.3 Construction Issues

The new bridge structure is to be constructed adjacent to the existing bridge structure. A number of issues are therefore to be addressed during construction to make sure the existing structure is unaffected by the construction activities and the affect on the existing rail traffic is minimised.

The foundation elements required to support the bridge structure are bored piles, so the construction procedure will need to allow adequate clearance to suit the boring rig. Adequate protection to the existing rail traffic is also required, as well as temporary embankment stabilisation or retaining walls during these construction activities.

Specifically, temporary excavations will be required at both ends of the bridge to construct the new bridge abutments and the abutment walls. The temporary excavations may be required to be retained via methods of sheet piling or sacrificial contiguous pile walls.

A short track possession will be required to place the prestressed precast voided rail girders onto the supporting abutments and intermediate piers. This would be required to minimise the risk of impacting with the existing rail traffic during cranage operations. If a possession is not considered at this time, adequate protection of the rail traffic to the construction zone is required to mitigate this risk. Temporary access and fall protection will be provided on the deck structure during construction until the up stand walls and the access walkways have been installed.

14. Range Road Grade Separation

14.1 Design Scope and Overview

Range Road is a rural collector road that links the New England Highway to the Golden Highway at Whittingham. It also provides the main access to the Singleton Military Base from the Singleton township. The existing level crossing on Range Road currently crosses two rail tracks and is controlled by active controls in the form of boom barriers and flashing lights. The current signposted speed limit on Range Road in the vicinity of the level crossing is 100km/h.

As part of the Minimbah Bank Third Track Project, it is proposed the existing Range Road level crossing is to be closed and replaced with a grade separated crossing to the north of the existing level crossing. As part of the works, a new intersection with the New England Highway will be required to the north on the existing intersection so that the approach roads to the intersection can be extended. This section of the report details the design process and output for the Range Road crossing, including justification for closing the existing level crossing, the road design for the grade separation and structural input for the grade separation structure.

Additional survey is required to the west of the Range Road level crossing, to tie into the existing alignment. The vertical and horizontal alignment tie-in for concept design is based on an extension of the existing vertical and horizontal grades. Additional survey of this area is required for detailed design. The southern connection to the existing alignment will also be confirmed following detailed survey.

14.2 Design Methodology

The Concept Design of the Range Road grade separation road and structure was progressed in unison with the concept design of the third track by applying the following methodology:

- A desktop study and site visit was undertaken to review the existing traffic volumes, current conditions of the road and level crossing, determine the constraints applicable to the design, and to identify the surrounding land uses;
- Site constraints that affect the concept design development were assessed;
- The existing level crossing current and future performances based on three tracks and reduced headways to 8 minutes were assessed. A submission to the Level Crossing Committee within ARTC, proposing to close the existing level crossing was prepared;
- Development of various road alignments and the associated structure for the Range Road grade separation; and
- Recommendation of a preferred grade separation option taking into account ARTC requirements, RTA preferences, Council requirements, and the documentation of the concept stage.

14.3 Design Parameters

The options and the final concept design for the Range Road grade separation road and structure were developed based on the standard design criteria detailed in the Design Criteria Report (DCR). Refer to Appendix B for reference to this document.

The main criteria and client preferences considered in the development of these options are noted below:

- 5.1m minimum vertical clearance for the Structure Gauge 1994 kinematic envelope above the top of rail. Note that the design of the Range Road grade separation structure does not allow for any future increased clearances to accommodate double stacking of containers;
- 3.5m vertical clearance for access roads adjacent to the tracks. Alternative routes will be provided for heavy or high vehicles;
- ARTC preference for no piers within the rail corridor;
- Specific bridge design limitations as detailed in Section 15.5.2;
- Increase safety by removing the existing level crossing;
- Maintain or improve the road design speed;
- Minimise capital costs, including earthworks, pavement, and structure costs;
- Minimise the quantity of property acquisition and property severance required; and
- Minimise requirements for rail track possessions and therefore minimise the impact on the existing rail traffic.

14.4 Existing Level Crossing Condition

The existing level crossing on Range Road is controlled by active controls in the form of boom gates and flashing lights. Recent works at the level crossing have installed temporary medians on the northern side of the level crossing.

Singleton Council have had reported behavioural incidents of people running the boom gates. This is primarily caused by trains starting from a stationary position at Whittingham Junction, which in turn activate the boom gates. Due to the slow speed the trains are travelling lengthy delays result, because of the time the boom gates are down.

Singleton Council have also confirmed that due to the level crossing and the boom gates being closed, cars have had to queue in the New England Highway auxiliary lanes while waiting for the trains to pass. From the hold line at the level crossing there is 53m to the edge of the left turn deceleration lane on the New England Highway. With the proposed third track at this location, there will be increased train volumes, increased train frequency, and increase the probability of masking trains. By locating the New Up main in the proposed location, the queuing distance to the New England Highway will be significantly reduced.

As part of this project, the Level Crossing Strategy Council was consulted to determine the ALCAM risk outputs for the level crossing. ALCAM is primarily a tool for the prioritisation of level crossing safety improvements, however, they can also be used for the identification and potential mitigation of risks at crossings. The Level Crossing Strategy Council considers a full risk assessment be undertaken especially where new level crossing facilities are being proposed. The ALCAM outputs for the existing level crossing have been reproduced in Table 14-1. This level crossing will be risk assessed in the detailed design.

Table 14-1 Range Road ALCAM Outputs

Risk	Impact
Extended advanced warning times.	Possible motorist impatience.
Conformance with AS1742.7.	Possible motorist confusion.
High proportion of heavy vehicles.	Slow vehicles, overhanging tracks, and potential increased consequences.
Long trains and low speed trains.	Motorist impatience, racing trains, and misjudgement of train speed.
High speed trains.	Racing trains and misjudgement of train speed.
Multiple tracks.	Limited sighting of trains and simultaneous trains.

The Level Crossing Strategy Council also confirmed that should a third track be built and the level crossing retained, this would be unique within NSW as being the only level crossing with three high speed main line tracks. The email providing ALCAM outputs is detailed in Appendix F.

It is noted that during development of the Range Road concept design both Singleton Council and the RTA have expressed a strong preference that the Range Road level crossing be replaced with a grade separated bridge.

Due to the reported behavioural incidents and the queuing issues which are assumed to worsen with the provision of a third track, the preferences of council and RTA, and the significant safety and maintenance benefits associated with closing a level crossing, the option of upgrading the existing level crossing or using a level crossing in a different location for Range Road was not considered further.

14.5 Site and Structural Constraints for Grade Separation

A significant number of constraints are apparent at the proposed location of the Range Road grade separation. These include geometrical constraints, structural constraints, existing infrastructure constraints and services constraints. These constraints are detailed below.

14.5.1 Geometrical Constraints

The location of the proposed Range Road grade separation is surrounded on all sides by various physical and geometrical constraints, which limit the alignment options at this location. These include:

- The existing dam on the western side of Range Road will potentially be covered by the realigned Range Road for the grade separation;
- The existing properties on the eastern side of Range Road limit any realignment options to the east of the existing road. Significant property acquisition issues would be apparent if a southern option was pursued;
- The proximity of the New England Highway to the Rail Corridor on the eastern side of Range Road limits the extent of options south of Range Road;

- The existing private airport west of the Range Road level crossing has a number of constraints relating to the air space around the airport. This includes an envelope of 5 degrees vertically in-line with the centreline of the runway from the Gable markers. It also includes an envelope horizontally of 10 degrees in-line with the runway from the Gable markers. This equates to a maximum height above the top of rail at the level crossing of approximately 15.5 m including vehicle and road furniture heights. This height limit reduces as the crossing moves north along the existing track alignment;
- An existing culvert structure under the existing rail is proposed to be extended as part of the concept design. The new Range Road grade separation structure needed to minimise its impact on this structure, as well as avoiding any potential issues relating to flood;
- An existing culvert on the New England Highway limits the distance north of the existing Range Road intersection, that a new intersection can be constructed. If the existing culvert is impacted by a new intersection, a major widening of the New England Highway would be required; and
- The entire area is in a low lying flood plain area impacted by flood backwaters from the Hunter River. As such, any options considered to go underneath the existing rail corridor would require significant drainage and alternative routes during floods.

14.5.2 Structural Constraints

The style of structure required at this location was chosen to be of simple construction so as to decrease construction time, reduce track possessions and impacts on existing rail traffic, and be cost effective. Based on these requirements, the style of structures to be considered, and the limitations or constraints on the road design have been listed below:

- A bridge superstructure consisting of prestressed precast T-Roff bridge girders with a composite concrete deck. This style of bridge girder allows for large spans while simplifying construction, with no requirements for onsite formwork over the rail corridor. Limitations relating to these style of structures include;
  - Spans are limited to approximately 35 m. Single span bridges will require less construction activity within the rail corridor and minimise rail track possessions;
  - Skew angles are limited to approximately 35 degrees;
  - Horizontal curve radius on the bridge deck must be minimised to allow for the curve within the top flange of the T-Roff girder only. That is, the top flange is to be either concave or convex to match the radius of the road alignment;
  - Vertical curves on the bridge deck should be minimised and vertical sag curves should be avoided; and
  - One way cross fall on the bridge deck can be provided, but super transition should be avoided to minimise deck thickness variations across the bridge.

- A bridge superstructure consisting of prestressed precast RTA deck units with a composite deck. This style of girder allows for much shorter spans but reduces structural depths. It is also a simple construction with no requirements for onsite formwork over the rail corridor. Limitations relating to these style of structures include;
  - Spans are limited to approximately 16m. Intermediate piers would be required therefore effecting the rail alignments, and would have to be designed for rail impact loading which are significantly large loads;
  - There is a potential for higher skew angles using this style of girder;
  - Horizontal curves cannot be accommodated within the girders or deck slab;
  - Vertical curves cannot be accommodated within the girders or deck slab; and
  - One way cross fall on the bridge deck can be provided, but super transition should be avoided to minimise deck thickness variations across the bridge.
- A precast concrete arch structure allows for the road design and the bridge design to be separated in terms of specific design levels, freeing up the options available in the road design as well as the structure. Limitations with this style of structure includes;
  - Precast arch structures are required to be square to provide an even loading on both sides of the structure. Skewed or splayed arch structures are not possible;
  - Sizes and profiles of arch structure are limited by the specific suppliers available; and
  - Minimum depths of fill are required over the top of the arch structures increasing the structural depth and therefore the height of the road embankment.

14.5.3 Existing Infrastructure and Services Constraints

A number of infrastructure items and services are located in the vicinity of the proposed Range Road grade separation structure. These include:

- The Range Road signal box. This is to be decommissioned once the Range Road grade separation has been constructed, but it must remain operational during construction of the grade separation; and
- A number of services are found in the vicinity of the proposed Range Road grade separation structure including Energy Australia underground high voltage cables, Telstra local and Main copper mains, Telstra optical fibre lines, Powertel / AAPT optical fibre lines and rail services along the length of the rail. These services will be either relocated or protected prior to the construction of the Range Road grade separation.

14.6 Options Considered in Design Development

Various options for the grade separation of Range Road were considered, taking into consideration the large number of constraints that are present at the site. The various options considered in the design development are discussed below. These options are illustrated in Figure 20.

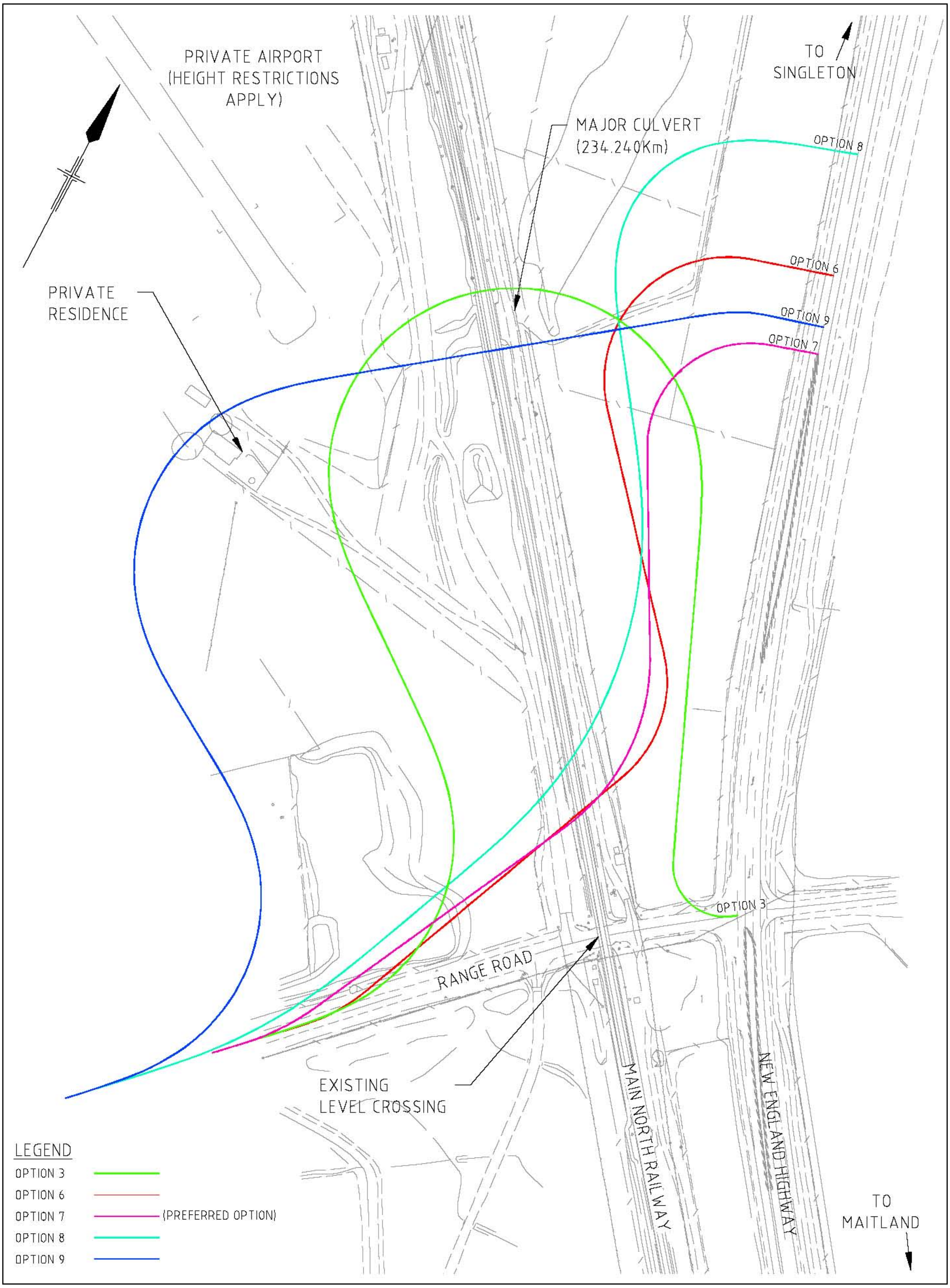

Figure 20 Range Road Grade Separation Alignment Options

14.6.1 Option 1- Existing Alignment with Rail over Road

An option was considered using the existing intersection and alignment of Range Road. The existing rail tracks and the proposed third track were required to be elevated over Range Road by including an inclined embankment north and south of Range Road and a viaduct style structure over Range Road. The benefits of this option are that the existing intersection of the New England Highway and Range Road would remain unaffected, a new alignment of Range Road would not be required, and only minor surfacing upgrades would be required to the road.

The main issues associated with this option include:

- A major operational criteria for the project is not met by requiring trains to climb another embankment prior to climbing the Minimbah Bank therefore using more fuel and increasing operational costs;
- A large quantity of additional earthworks would be required to construct the approach embankments on the rail track, due to the overall length of the embankment required to suit the structural clearance at Range Road and the slight grade required by the rail track;
- A significant impact would be imposed on the existing rail traffic due to delays during construction of this option;
- A significant size bridge structure would be required to carry the two existing tracks, the proposed third track and the access roads on the Up and the Down; and
- The height of the embankment to the north of Range Road would be within the airport clearance requirements.

As this option does not meet a number of specific project criteria it was discarded.

14.6.2 Option 2 – Existing New England Highway Intersection – Road over Rail to the South

An option was considered for Range Road to cross the rail corridor south of the existing Range Road level crossing. The new alignment of Range Road would start at the existing New England Highway intersection and turn to the left, climb up adjacent to the proposed third track, cross the bridge at a single span bridge over the three tracks, and then head north back towards the existing Range Road alignment. The main benefit of this option is that the existing Range Road / New England Highway intersection is reused as part of the grade separation.

The main issues associated with this option are:

- The road alignment required to fit within the area between the New England Highway and the rail corridor does not meet the Road Design Guide minimum standards;
- Significant retaining walls would be required along the length of the new road to retain the embankment between the New England Highway and the rail corridor;
- A significant area of property acquisition including a number of existing buildings would be required as part of this option; and
- Due to the alignment of the road over the rail corridor, the bridge structure would require a significant variation in deck slab thickness across its length.

As this option is unachievable from a Road Design point of view, it was also discarded.

14.6.3 Option 3 – Existing New England Highway Intersection – Road over Rail to the North

An option was considered from Range Road to cross the rail corridor north of the existing Range Road level crossing. The new alignment of Range Road would start at the existing New England Highway intersection and turn to the right, climb up adjacent to the proposed third track, cross the bridge at a single span bridge over the three tracks, and then head south back towards the existing Range Road alignment. The main benefits of this option is that the existing Range Road / New England Highway intersection is reused as part of the grade separation, and the new road alignment take advantage of the additional room north of the existing intersection, therefore minimising any need for retaining walls.

The main issues associated with this option are:

- The first curve of the realigned Range Road at the existing New England Highway intersection is significantly under sized and does not satisfy the requirements of the Road Design Guide;
- The height of the embankment at the bridge crossing location will be within the air space clearance envelope for the airport since the bridge crossing would be much further north than any of the other options; and
- The existing culvert crossing the rail corridor will be impacted by the location of the new bridge structure and the road embankment. This may either require relocation of the culvert or significant drainage works within the new road embankment design.

As this option is unviable from a Road Design point of view, and it is also within the air space envelope for the private airport, it was considered unacceptable. As such, this option was not considered further.

14.6.4 Option 4 – Underpass on New Range Road Alignment

An option was considered to realign Range Road to cross underneath the existing rail corridor at a new bridge structure. To make adequate room for the new road to fall enough to provide adequate clearance under the new bridge structure, the Range Road alignment needs to start at a new intersection of the New England Highway, north of the existing intersection. The main benefits of this option is that the height of the embankment underneath the air space clearance envelope is no longer an issue.

The main issues associated with this option include:

- A new intersection of Range Road and the New England highway would be required as part of this option, which will include pavement widening and additional acceleration and deceleration lanes;
- The road would need to be excavated under the existing ground level so as to fall enough to achieve the required clearances. The geotechnical properties of the existing material at the site are unknown but given the area is a prone to flooding, it is likely to be very weak silty or sedimentary material. The required batter slopes would be very flat, and any retaining walls difficult to construct;
- The road would likely be constructed below the water table, and is also going to be prone to flooding. A permanent drainage and pump system would need to be included at the base of the crossing to ensure that any ground water, storm run-off or flood events can be pumped clear of the structure; and
- The bridge would need to be designed to support the existing rail tracks as well at the third track and the two access tracks running on both sides of the corridor. A number of possessions would be required to construct this structure, including boring of the foundation elements, and installation of the headstocks and deck units.

Since this option is considered to be very difficult to construct, and will be very expensive in the long term to maintain, it was not considered further.

14.6.5 Option 5 – Rail and Highway Overpass – Grade Separated Interchange

An option was considered to make the existing Range Road intersection with the New England Highway a grade separated interchange. The option included a simple single span bridge crossing the existing rail tracks and the proposed third track, and continuing to another bridge structure crossing across the New England Highway at this location. The main benefit of this option was to keep the existing Range Road on its current alignment, to simplify the structure requirements crossing the rail corridor, and improve the safety of the existing New England Highway intersection by grade separating the intersection;

The main issues associated with this option are:

- The size and number of major structures in this option will make if a very expensive option. This includes an additional major bridge crossing the New England Highway; and
- A number of on and off ramps would be required from north and south approaches to the interchange. Due to the minimal additional room between the highway and the rail corridor, it would be likely that there would be a very large quantity of retaining walls along the length of the highway on both approaches.

Due to the significant capital costs related to this option, and that there are minimal advantages to the ARTC or the RIG in these expenses; this option was not considered further.

14.6.6 Option 6 – New Alignment North of Range Road – 50km/hr

An option was developed to realign the existing Range Road slightly to the north, crossing the rail corridor slightly north of the Range Road signal box. The new Range Road alignment would intersect the New England Highway approximately 200 m north of the existing intersection. The road alignment was chosen with curve radii to satisfy a 50km/hr design speed. A number of iterations on this alignment were developed to try and satisfy the structure constraints noted above in Section 15.5.2 for a standard precast T-Roff style structure. These constraints included removing any super transition from the bridge deck, removing horizontal curve transitions from the bridge deck, ensuring a constant horizontal curve across the bridge deck is achieved within the constraints of the T-Roff girders, and trying to minimise the skew at the rail crossing. The development of the new Range Road alignment was unable to satisfy a standard style bridge structure without significant modifications to the structure.

It was considered that an arch structure be used to span over the rail corridor and to support the new Range Road alignment. Option 7 following was developed to suit the arch style structure.

14.6.7 Option 7 – New Alignment North of Range Road – 50km/hr

This option was developed following the iterations completed in Option 6. The required structural clearances over the rail tracks and the access roads were determined and a precast concrete arch profile was fitted over the tracks ensuring these clearance requirements were met. The road design was then completed based on achieving a minimum of 1.5 m of fill over the top of the arch structure. The main benefits of this option is that the road alignment is not governed by the limitation of the bridge structure, the main design criteria at this location were met, the proposed structure type is a precast prefabricated style structure that can be installed quickly and easily within a single track possession, and the foundations of the arch structure can be constructed clear of the existing rail tracks, therefore minimising impacts on the existing rail traffic.

The main issues associated with this option are:

- A new intersection of Range Road and the New England Highway is required to be constructed including pavement widening for new acceleration and deceleration lanes;
- The clearance allowed for through the arch only allows for a single access track on the Up to access the arch structure. The clearance provided at this access track is only 3.5 m which is satisfactory for typical maintenance vehicles;
- The new structure is to be constructed close to the existing signal box. The design ensures that the existing signal box can remain in service until the new Range Road is opened to traffic;
- The dam on the northern side of Range Road will need to be filled in as part of the new alignment, and further geotechnical studies will have to be competed to ensure the embankment design at these locations is satisfactory; and
- The arch structure is to be supported on a shallow bearing style foundation. Since the geotechnical properties of the existing material at the site are unknown, an allowance for a piled soil raft has been made in the documentation and the costing. The need for such treatment or any other cost effective alternative will be considered when appropriate geotechnical information is available during the detailed design phase.

14.6.8 Option 8 – New Alignment North of Range Road – 80km/hr

This option was developed following the iterations completed in Option 6 and 7. The precast concrete arch structure was adopted to carry the road over the rail corridor providing structural clearances and minimum fill depths in the road alignment. Since the road alignment does not govern the requirements for the structure as in Option 7, an appropriate road design could be completed allowing for a higher design speed at this location. An 80km/hr design speed was adopted so as to match the current conditions of Range Road at this location.

The main benefits of this option are that the road alignment is not governed by the limitation of the bridge structure. Therefore a higher design speed on Range Road could be satisfied and the main design criteria at this location were met. The proposed structure type is a precast prefabricated style structure that can be installed quickly and easily within a single track possession. The foundations of the arch structure can be constructed clear of the existing rail tracks therefore minimising impacts on the existing rail traffic.

The main issues associated with this option are:

- The higher design speed requires a shallower curve at the crossing location. The length of the arch structure required to support the road will be significantly longer than the arch required in Option 7;
- The new Range Road alignment would tie in to the existing Range Road further west making the overall pavement and road works more extensive than Option 7;
- The higher design speed at this location is likely not to be preferred by the authorities. A traffic controlling road design would be preferable on the approach to a major intersection on the New England Highway;
- A new intersection of Range Road and the New England Highway is required to be constructed including pavement widening for new acceleration and deceleration lanes;

- The clearance allowed through the arch only allows for a single access track on the Up to access the arch structure. The clearance provided at this access track is only 3.5 m which is satisfactory for typical maintenance vehicles;
- The dam on the northern side of Range Road will need to be filled in as part of the new alignment to provide adequate room for the embankment design; and
- Due to the limited geotechnical information available further geotechnical studies will have to be completed in this area.

Although the overall concept design is similar to Option 7, the capital costs are significantly higher. This option was therefore not considered further.

14.6.9 Option 9 – New Alignment North of Range Road – Straight Approach to Intersection

Option 9 is similar to the previous options for a new alignment north of Range Road. However, this option uses a tight radius curve to move away from Range Road and cross the rail corridor at 90 degrees. This is essentially a straight approach to a new intersection with the New England Highway. This option provides an easier bridge design as it has a straight alignment across the rail corridor and with a minimum span.

The main issues associated with this option include:

- The height of the embankment at the bridge crossing location will be within the air space clearance envelope for the nearby private airport;
- There would be considerably more land acquisition required for this option. The alignment also conflicts with an existing house which poses further property acquisition issues;
- The existing culvert crossing the rail corridor will be impacted by the location of the new bridge structure and the road embankment. This may either require relocation of the culvert or significant drainage works within the new road embankment design; and
- This option reduces the approach distance to the rail from the proposed intersection, and requires a larger vertical grade, which would potentially be not compliant with the RTA's RDG.

Due to the option being within the airports clearance envelope and the additional works that would be required to other aspects of the project, this option was not considered further.

14.6.10 Recommendation

Based on the above summation of the options considered, a general overview of capital costs, a review of the required constraints to be satisfied, and by a method of elimination, the preferred option chosen to be developed as part of the final concept design is Option 7 a new alignment north of Range Road with a design speed of 50km/hr.

14.7 Road Concept Design

14.7.1 Preferred Option Description

The Range Road preferred option involves closing the existing level crossing and providing a grade separated overbridge to the north of the existing level crossing. A new alignment of Range Road will be required to link the existing alignment to the proposed bridge and then to the New England Highway. This will also involve a new intersection with the New England Highway. A 50km/hr design speed has been used for Range Road, and this is based on the radius of the approach curve to the New England Highway. Standard RTA lane widening was used to account for heavy vehicles using Range Road through tight curves.

The proposed alignment of Range Road was developed to avoid the existing signal box near the level crossing, which will allow the operation of the level crossing to continue while construction of the grade separation occurs. This will greatly reduce the impact to traffic on Range Road, and will prevent a substantial cost to ARTC to relocate the signal box, only to remove it after the grade separation has been constructed.

14.7.2 Non Conformances

The following non-conformance to the RTA's RDG has been noted for the Range Road concept design, for a design speed of 50km/hr:

- Advised superelevation for rural roads is 7%. However, due to the low speed environment and the required vertical grades, 7% was considered too high and potentially could cause a heavy vehicle to tip over should it stall on the road. Hence, 5% superelevation was adopted for the Range Road concept design.

Range Road concept design non-conformance will be reviewed and confirmed at detailed design in consultation with RTA, ARTC and Singleton Council.

14.7.3 Horizontal and Vertical Alignment

The horizontal alignment of the proposed Range Road alignment is based on a 50km/hr design speed, which is based on the radius of the approach curve to the New England Highway. A 50m radius curve was used on approach to the intersection, which was required to make the horizontal curve in the limited space available at this location.

A 100m radius horizontal curve was used across the arch structure over the rail tracks. This curve prevented the proposed Range Road alignment conflicting with the signal box for the existing level crossing. A slight adjustment to the location of this curve will occur at detailed design stage to provide a little more room at this signal box.

The vertical alignment of the proposed Range Road alignment uses standard curves to link the intersection with the New England Highway with the grade separated overbridge and the existing Range Road. The maximum vertical grade used was 7.75% which is keeping with the RTA RDG which is specified as the relevant standard by the latest adopted Singleton Council DCP.

14.7.4 Cross Section

The following cross section has been provided for the Range Road concept design:

- A 3.5m through lane in both directions;
- 3.0m shoulders on both sides of the road; and
- 1.0m verge has been provided from the trafficable face of the guardrails to the top of the fill embankment.

Standard RTA lane widening has been adopted through the proposed alignment to account for heavy vehicles travelling through tight curves.

14.7.5 Crossfall and Superelevation

3% dual crossfall has been provided on straight horizontal alignments on Range Road. Through the horizontal curves 5% superelevation has been provided, along with standard RTA superelevation transitions.

14.7.6 Batters

2(H): 1(V) batter slopes have been adopted for areas where the Range Road alignment is in fill.

14.7.7 Guardrails and Barriers

Where the Range Road alignment is in significant fill, W-Beam guardrails have been provided. These transition to Thrie beams across the bridge structure. Standard RTA transitions, MELTS, and Trailing Terminals are to be used for the guardrails.

14.7.8 Pavement and Earthworks

The pavement design for Range Road is to be completed as part of the geotechnical investigations in the detailed design. For costing purposes, a previously used pavement design for the Golden Highway has been adopted. The pavement design is to be confirmed following geotechnical investigations and incorporated into the detailed design.

As we are providing a grade separated bridge to replace an at grade crossing, nearly all of the proposed Range Road alignment is in fill. This means that there will be significant fill associated with the Range Road design, this has been incorporated into the overall earthworks balance for the project. The fill material is to be brought to the site from other areas of the project.

14.7.9 Intersection with the New England Highway

Due to the additional approach distance required to develop the vertical curve over the rail tracks at sufficient vertical clearance, a new intersection with the New England Highway is required. The intersection arrangements will be the same as what is currently provided at the existing intersection of the New England Highway and Range Road.

The intersection provides left turn acceleration and deceleration lanes, and a right turn deceleration lane on the New England Highway. No right turn acceleration lane has been provided for the right turn into the New England Highway.

The location of the proposed intersection was limited in the distance it could move north along the New England Highway. This is due to the existing culvert on the New England Highway, which prevents widening of the road at this point. So to fit in the required right turn deceleration lane on the New England Highway, the proposed intersection location is at the limit of this lane widening. This means that the right turn deceleration lane begins immediately after the existing culvert.

14.7.10 Pavement Drainage and Cross Drainage

On the northern side of the rails, the Range Road concept has been designed so that the stormwater flows on the road are directed into channels that outlet through existing culverts under the New England Highway.

On the southern side of the proposed Range Road alignment, crossfalls has been design to direct stormwater flows off the road to be captured by the rail cess drains or by the culvert at chainage 234.240 km, which will be extended to suit the proposed third track as part of the Minimbah Bank Third Track Project. Stormwater is then directed into a channel that outlets the flows through an existing culvert beneath the New England Highway.

Scour protection will be required on some batters to protecting it from eroding in heavy storms and floods.

Drainage for the Range Road grade separation will be reviewed at detailed design stage.

14.7.11 Construction Issues

The following construction issues are associated with the road design aspect of the Range Road concept design:

- The dam on the southern side of Range Road will need to be filled in as part of the new alignment, and further geotechnical studies will have to be competed to ensure the embankment design at these locations is satisfactory;
- Construction around the signal box near the existing level crossing will need to managed correctly to prevent conflict with the building and cause problems with the existing level crossing during construction; and
- There will be traffic impacts when constructing the new intersection with the New England Highway and the tie-in with the existing Range Road alignment. A clear and concise traffic management plan will reduce the implications of these traffic impacts.

14.7.12 Interface with Bridge Design

The interface of the road surface and the bridge structure is to be detailed at detailed design stage.

14.8 Structure Concept Design

14.8.1 Design Loads and Criteria

The Range Road grade separation structure was designed based on:

- The horizontal and vertical road alignments determined based on Option 7 in the option development stage;
- The Design Criteria for rail bridges as stipulated in the Design Criteria Report. Refer to Appendix B reference to this report;
- Preliminary aerial survey. Minimal survey of the existing road was available during this phase of the project, and any deficiencies in the design will be determined once adequate survey has been received during the detailed design phase of the project; and
- Minimal geotechnical information. A desktop study and a walk through, was completed as part of the concept design phase of the project. No geotechnical investigations or testing was completed in this stage of the project. As the selected structure relies heavily on the performance of shallow foundations, detailed geotechnical information will be required during the detailed design phase.

14.8.2 Structure Design and Arrangement

The concept design of the Range Road grade separation structure is a precast concrete arch structure with an internal span of 21.0 m, and an internal rise of 7.0 m. The precast concrete arch structure is a proprietary system manufactured by specialist suppliers. The Humes 'Classic Arch' profile was used for the concept design arrangement. The precast concrete arch has been designed parallel to the existing and proposed rails allowing adequate vertical and horizontal clearances to the rails and the access track as detailed in the Design Criteria Report. The arch structure is approximately 41.0 m long and starts at approximately chainage 234.000km. The road design over the top of the arch structure has been completed allowing for a minimum depth of fill of the apex of the arch of 1.5 m. The road design has been determined based on the constraints at the site, and is on a skew, horizontal curve and a vertical curve as it intersects the arch structure.

An option was considered to align the proposed third track closer than the 6.5 m offset adopted typically for the project. The advantage of realigning the new track allows for the arch structure to be placed lower while still achieving the required clearance, and reduced the height of road embankment and therefore the quantity of fill material required. This option was discounted as there are existing signal structures along the length of the track that will not allow the track centres to be reduced.

The arch itself is supported on a reinforced concrete footing structure proportioned specifically to resist the loads from the arch including self weight, soil weights and the vehicular live loads. Due to the lack of geotechnical information available at the site during the Concept Stage of the design, an assumed ground improvement including a reinforced soil raft and driven piles has been adopted to increase the allowable bearing capacity of the natural ground to resist the loads imparted from the arch footing. Once detailed geotechnical investigations have been completed, the specific requirement for these ground improvements will be reviewed and are liable to change.

The arch footing has also been proportioned to allow for the clearance requirements through the arch structure, by raising the base of the arch 900 mm above the top of rail level. The arch spans over the existing Down main, the existing Up main, the proposed New Up main and the proposed Up access track. The access track on the Down is not continued through the arch structure.

At each approach to the arch structure, proprietary wing walls and spandrel beams are used to retain the earth embankment. The wing walls have been arranged at 90 degree and 120 degree angles from the face of the arch structure, so as to match the batter slope of the road embankment.

To provide adequate safety of the pedestrians and vehicles using this structure, a pedestrian fence will be installed along the full extent of the arch spandrel and wing walls to prevent potential falls into the rail corridor. The road users will be contained between heavy duty thrie beam barriers across the full extent of the arch structure positioned on the outside edge of the shoulder.

The extent of the arch structure and therefore the road design was determined to minimise the impacts on the existing signal box during the construction phase of the project. The current concept arrangement shows the wing walls on the south eastern corner of the structure passing by the outside edge of the signal box. The location of the arch will be revisited once detailed survey is available at this location.

14.8.3 Construction Issues

The Range Road arch structure will be constructed north of the existing Range Road level crossing. The arch structure will be separated from the existing Range Road therefore minimising any disruption to road traffic during the construction phase. Earthworks operations related to constructing the embankments will potentially affect the existing road users and will subject to a Traffic Management Plan (TMP).

The arch style structure has been selected to assist in minimising the impacts of the construction of the arch on the existing rail traffic. The precast concrete arches are supported on footings either sides of the rail corridor. These footings as well as the ground improvements for these footings will be able to be constructed with minimal impact on the rail traffic. Temporary excavations and shoring maybe required adjacent to the existing tracks during this process.

The precast arch elements are installed in 1.8 m wide sections, and each arch is separated into two parts, with a joint running along the apex of the arch. The arch elements will need to be installed during a possession, and significant crane operations will be required for installation within the allotted possession (s).

Once all of the precast elements have been installed, there will be minimal disruption to the rail traffic based on the requirements for construction of the earthwork embankments. Other than those noted above in Section 14.2.

15. Major Culvert Structure (Ch 234.240km)

15.1 Design Scope and Overview

The northern end of the Minimbah Bank Third Track Project is within a low lying area prone to flooding. There are a number of large flood relief structures along the length of the existing track north of Range Road that provide this flood relief under the rail formation.

The existing Major Culvert and flood relief structure at chainage 234.240 is a four span 21.0 m long structure supporting the existing Up and DOWN mains. The existing structure is an insitu concrete deck structure with upstand walls retaining the rail ballast and track formation. The deck structure is supported on reinforced concrete abutment walls supported on a ground slab.

The proposed third track at this location will be offset from the existing Up main by 6.5 m. The new structure required to support this track will be constructed adjacent to the existing structure, ensuring minimal impact of the existing structure, the existing rail traffic, and to minimise the impacts of the hydraulic characteristics of the structure.

This section of the report details the design process and output for the concept design of the Major Culvert Structure at chainage 234.240.

15.2 Design Methodology

The Concept Design of the Major Culvert at chainage 234.240km was progressed in unison with the concept design of the third track by applying the following methodology:

- A desktop study and site visit was undertaken to review current conditions of the existing culvert, determine the constraints applicable to the design, and to identify the surrounding land uses;
- Site constraints that affect the concept design development were assessed;
- The structural concept was progressed ensuring loading and authority requirements were considered in accordance with the Design Criteria Report; and
- The concept design was documented for the concept stage.

15.3 Design Parameters

The concept design for the Major Culvert at chainage 234.240 was developed based on the standard design criteria detailed in the Design Criteria Report which is attached to this report.

The main criteria and client preferences considered in the development of these options are noted below:

- A 2.5 m horizontal clearance to any fixed items for the Structure Gauge 1994 kinematic envelope was adopted;
- To minimise impacts on the existing floodway area, the new structure will mimic the existing structure in terms of span lengths and structural form. Detailed flood analysis of the area was not completed as part of the concept stage. Flood levels and requirements will be reviewed during the detailed design;
- The superstructure will be designed with flood immunity under serviceability load cases to the 1:100 year ARI. Once a detailed flood analysis has been completed, the flood immunity of the structure under the 1:2000 year flood event will be checked; and
- Minimise requirements for rail track possessions and impacts on existing rail traffic.

15.4 Concept Design Development

The information available relating to the existing structure was minimal, therefore the concept design was developed based on assumptions and site measurements. The information available, and the information lacking relating to this structure included:

- Site inspection notes, measurements and photos were available to assist in the development of the concept design;
- Detailed Design Drawings or Work As Executed drawings for the culvert structure were not available;
- No geotechnical investigations or information was available at the site;
- No existing flood levels or flood studies were completed or available for the site; and
- Aerial survey of the existing rail corridor was completed, but no detailed survey of the structures was completed during the concept design phase.

Following is a description of the information considered and the design development completed based on this information.

15.4.1 Hydrological and Flood Impacts on Concept Design

As no existing flood studies were available at the site, and no detailed flood studies were completed during the concept design phase, assumptions on the hydraulic capacity of the existing structure and the new structure had to be made.

To simplify the concept design, it was assumed that the existing structure has sufficient hydraulic capacity to withstand the flood events in this area. It was therefore, assumed that the proposed new structure will have sufficient hydraulic capacity as long as the same waterway area is provided. The concept design was therefore progressed providing a new culvert of similar structure form as the existing structure, and maintaining the existing waterway area.

The deck structure of the proposed new culvert will be laterally restrained to its supporting foundations by up stand corbels which will resist any additional lateral loading from flood events.

15.4.2 Geotechnical Implications on the Concept Design

The location of the proposed culvert is in a low lying area prone to flooding, so assumed that the existing material at the site would consist of a considerable depth of soft sedimentary alluvium material over laid on a bedrock stratum.

Once the detailed geotechnical investigations have been completed, this will be confirmed or modified to suit.

Based on the above assumptions, the foundation requirements for the proposed structure consisted of driven pile foundations to support the abutment walls off the culvert structure.

15.5 Structural Concept Design

15.5.1 Design Loads and Criteria

This structure is designed based on:

- The horizontal and vertical rail alignments determined in the concept rail and earthworks design;
- The Design Criteria for rail bridges as stipulated Design Criteria Report;
- Preliminary aerial survey. Detailed survey of the entire rail corridor and the existing culvert structure will be completed prior to progressing the design in the detail design stage; and
- Geotechnical assumptions only. Detailed geotechnical investigations will be completed at the site prior to commencing the detailed design phase.

15.5.2 Structural Design and Arrangement

The concept design of this Major Culvert is a 4 span, prestressed precast voided rail girder ballasted top deck parallel to the existing culvert at this location. The overall length of the structure is approximately 21.0m long with spans typically 5.5m in length. The spans will be simply supported on elastomeric bearing strips over the reinforced concrete abutment walls. The deck has been restrained laterally to the substructure using up stand corbels at the edges of the pier and abutment walls. This provides restraint against loading such as train nosing loads, earthquake loads, and lateral flood loads. Upstand walls have been incorporated into the deck to retain the ballast formation over the length of the structure. The deck has been designed to be level with adequate drainage provided through the Upstand walls to remove water during storm events.

The sub structure consists of a full length ground slab with reinforced concrete up stand walls to support the deck. The abutments and internal piers will be supported using bored concrete piles socketed into bedrock. Reinforced concrete wing walls will be incorporated into the abutment walls to retain the formation at each approach to the structure.

A ballast box approach slab has been incorporated into the concept design so as to retain the ballast formation at the approach to the structure, and to minimise direct lateral loading due to the surcharge of the trains on the back face of the abutment walls.

15.5.3 Construction Issues

The new structure is to be constructed adjacent to the existing structure, so there will be a number of issues to be addressed during construction so the existing structure is unaffected by the construction activities and the affect on the existing rail traffic is minimised.

The foundation elements required to support the structure are bored piles, meaning the construction procedure will need to provide adequate clearance to suit the boring rig, adequate protection to the existing rail traffic, and temporary embankment stabilisation or retaining walls during these construction activities.

A track possession will be required to place the prestressed precast voided rail girders onto the supporting abutments and intermediate piers. This would be required to minimise the risk of impacting with the existing rail traffic during cranage operations. If a possession is not considered at this time, adequate protection of the rail traffic to the construction zone would be required to mitigate this risk.

The abutment walls of the existing culvert structure will need to be modified during construction to suit the requirements of the new structure. These construction operations should be completed with minimal effect on the existing rail traffic.

Appendix A

Signalling Functional Specification

Appendix B

Design Criteria Report

Appendix C

Property Acquisition – Impacted Properties and Quantities

Appendix D

Existing ARTC Services Plans

Appendix E

Layout Drawing for Rail Services in Conduits

Appendix F

ALCAM Outputs

Appendix G

Geotechnical Desk Top Review

Appendix H

Junction Configurations, Operational Issues and Criteria Assessment

Appendix I

Discussion Paper on Additional Third Track Alignment and Whittingham Junction Flyover Option

Appendix J

Flora and Fauna Route Options and Constraints Assessment

Appendix K

Environmental Assessment and Approvals

Appendix L

Property Acquisition Risk Assessment Report

Appendix M

Preferred Options Maintenance Regimes

Appendix N

Preferred Options Report

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Appendix B

Flora and Fauna Route Options and Constraints Assessment

FLORA AND FAUNA ROUTE OPTIONS AND CONSTRAINTS ASSESSMENT

PROPOSED THIRD RAIL TRACK FOR THE MINIMBAH BANK NEAR BELFORD

DRAFT REPORT

Prepared for
GHD Pty Ltd & ARTC

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1.0 INTRODUCTION

1.1 Background and Scope

This Flora and Fauna Route Options and Constraints Assessment Report has been prepared at the request of Mr Simon Page of GHD Pty Ltd on behalf of the Australian Rail Track Corporation Ltd (ARTC). Three possible alignments for the proposed Minimbah Bank third rail track near Belford are under consideration and this report will investigate the potential ecological impacts of each of the alternative routes. This information contained in this report will assist GHD Pty Ltd in the determination of a preferred alignment option for the proposed third rail track.

These activities are hereafter referred to as *the Proposal.*

The general aims of this assessment are to:

- ➢ describe the existing biological environment of the study area in relation to flora and fauna;
- ➢ discuss the potential impacts of the proposal for any threatened species that occur or could be likely to occur in the subject site;
- ➢ provide discussion on measures to mitigate impacts.

The environmental studies have been conducted in three stages:

(a) the first stage being a review of available literature pertaining to the site and surrounding locality and preliminary habitat assessment of the subject site;

(b) the second stage being the completion of targeted field surveys for threatened species regarded as potential subject species, and surveys to investigate the inherent biological attributes of the site; and

(c) the third stage being the assessment of impact of the proposal on flora and fauna in accordance with the relevant NSW and Commonwealth legislation and planning instruments.

Within this report, reference is given to the relevant sections of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act); NSW *Threatened Species Conservation Act 1995* (TSC Act); *National Parks and Wildlife Act 1974* (NP&W Act); *Environmental Planning and Assessment Act 1979* (EP&A Act); and subsequent amendments to these. Specific consideration is given to Section 5A of the *EP&A Act*.

For this report,

- the *subject site* is defined as the land area potentially directly affected by all three proposed alignments for the Minmbah Bank third rail track route. All three proposed alignments are approximately 10km in length and for the most part run adjacent to the existing rail track. The third alignment deviates along the New England Highway from Belford, rejoining the existing track just north of the Golden Highway;
- the *study area* consists of the subject site plus the immediately surrounding land and watercourses that could be potentially affected directly or indirectly by the proposal; and
- the *study locality* is the area of land within a ten (10) kilometre radius of the centre of the subject site.

1.2 General Description of the Study Area and Study Locality

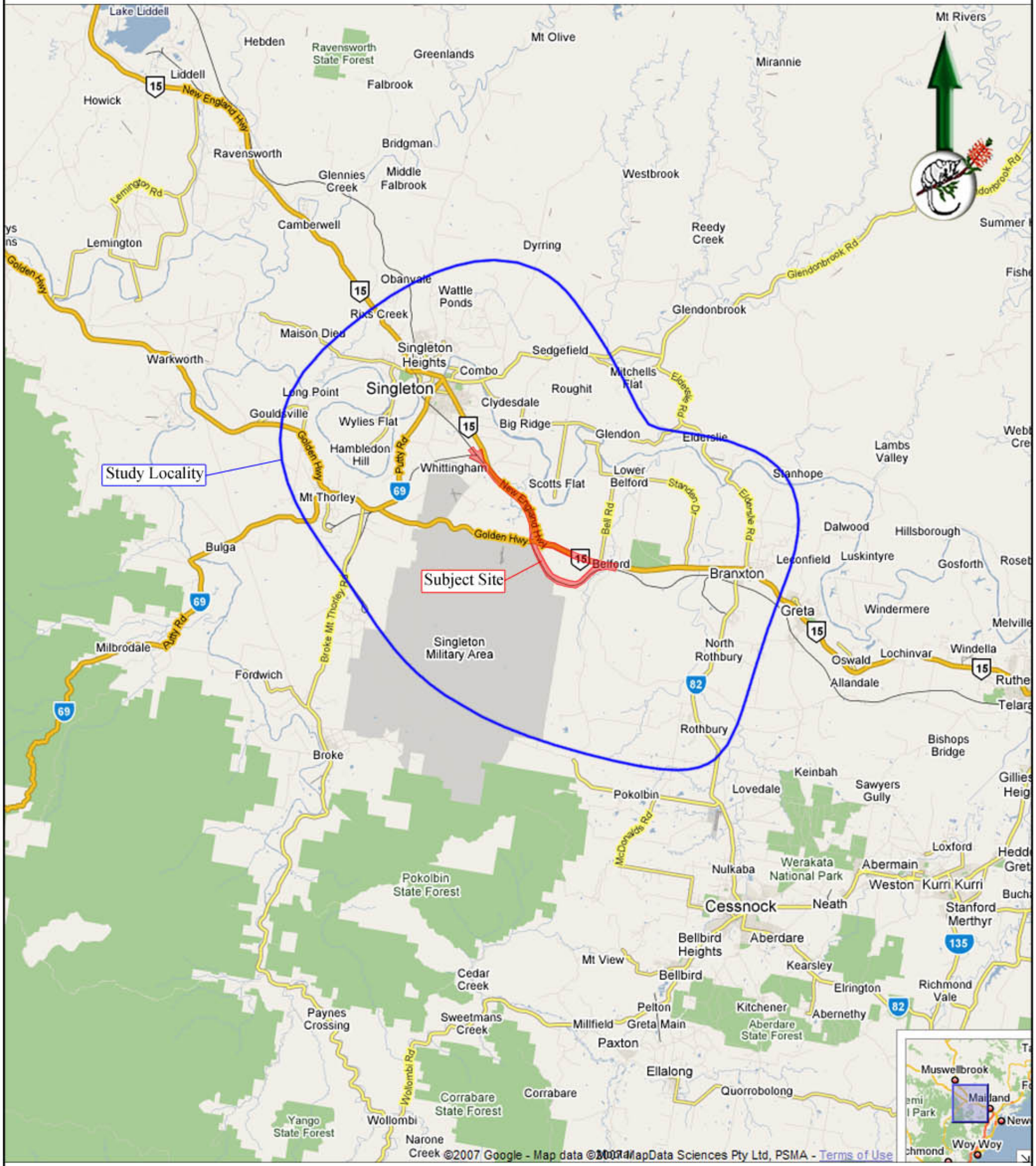
A broad description of the prominent natural and developed features of the study area and study locality is provided in **Table 1** below. The location of the study area within the study locality is shown in **Figure 1**.

Table 1. Description of the Study Area and Locality

Client	Australian Rail Track Corporation Ltd (ARTC)
Location	Between Whittingham Junction and Belford along the Main Northern Railway Line and New England Highway (approximately 10km south of Singleton). Map sheet: 9132 Cessnock 1:100000 Zone 56 329800E 6392100N to 338800E 6385200N (GDA94)
LGA	Singleton
Bioregion	Sydney Basin
Botanical Subregion	North Coast
Study Locality Description	The study locality consists predominantly of agricultural and grazing lands, though some areas of native vegetation remain. It includes the urban centres of Singleton, Branxton and Rothbury as well as a number of smaller localities. Native vegetation within the study locality occurs in Belford National Park, Singleton Military Area and on private lands. The Hunter River flows through the study locality to the north of the subject site.
GEOLOGY	Mixed – gravel, sand, silt and clay alluvial of the Hunter River floodplain and Maitland Group siltstone, sandstone, conglomerate and mudstone.
ELEVATION	Approximately 40m to 100m asl
SUBJECT SITE DESCRIPTION	Generally flat floodplain of the Hunter River and its tributaries at the western end, more undulating at the eastern end. The site is almost completely cleared and treeless at the western end, with remnant disturbed and partially cleared vegetation (often reduced to the tree layer) and some plantations (olives and vineyards) at the eastern end.
CURRENT LANDUSE AND GENERAL CONDITION	Transport - major 2-track railway and two major highways (New England Highway and Golden Highway) within site. Farming, grazing, olive plantations and vineyard beyond transport easements.
Significant features	A number of creeks/drainage lines run through the subject site and drain into the Hunter River to the north, including Jump-Up Creek and Mudies Creek.
SURROUNDING LANDUSE	Surrounding landuse is predominantly rural, with much of the surrounding land cleared for grazing. Some areas of native vegetation occur, in particular within Singleton Military Area and Belford National Park. The subject site includes the localities of Belford and Whittingham.

1.3 Description of the Proposal

On behalf of ARTC, GHD Pty Ltd are preparing a design for a third rail track at Minimbah Bank between Whittingham Junction and Belford on the Main Northern Railway Line. Three possible alignments for the third rail track are under investigation. Two of the potential alignments run either side of and parallel to the existing track (Option 6 – the ‘Up’ Option and Option 7 – the ‘Down’ Option) and the third option (Option 1) deviates along the New England Highway from Belford to rejoin the existing track just north of the Golden Highway (**Figure 2**).



Base Map Source: Google Maps http://maps.google.com.au

0 5 10km

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Figure 1. Study Locality

Flora and Fauna Constraints Assessment: Proposed Third Rail Track at Minimbah Bank near Belford	November 2007

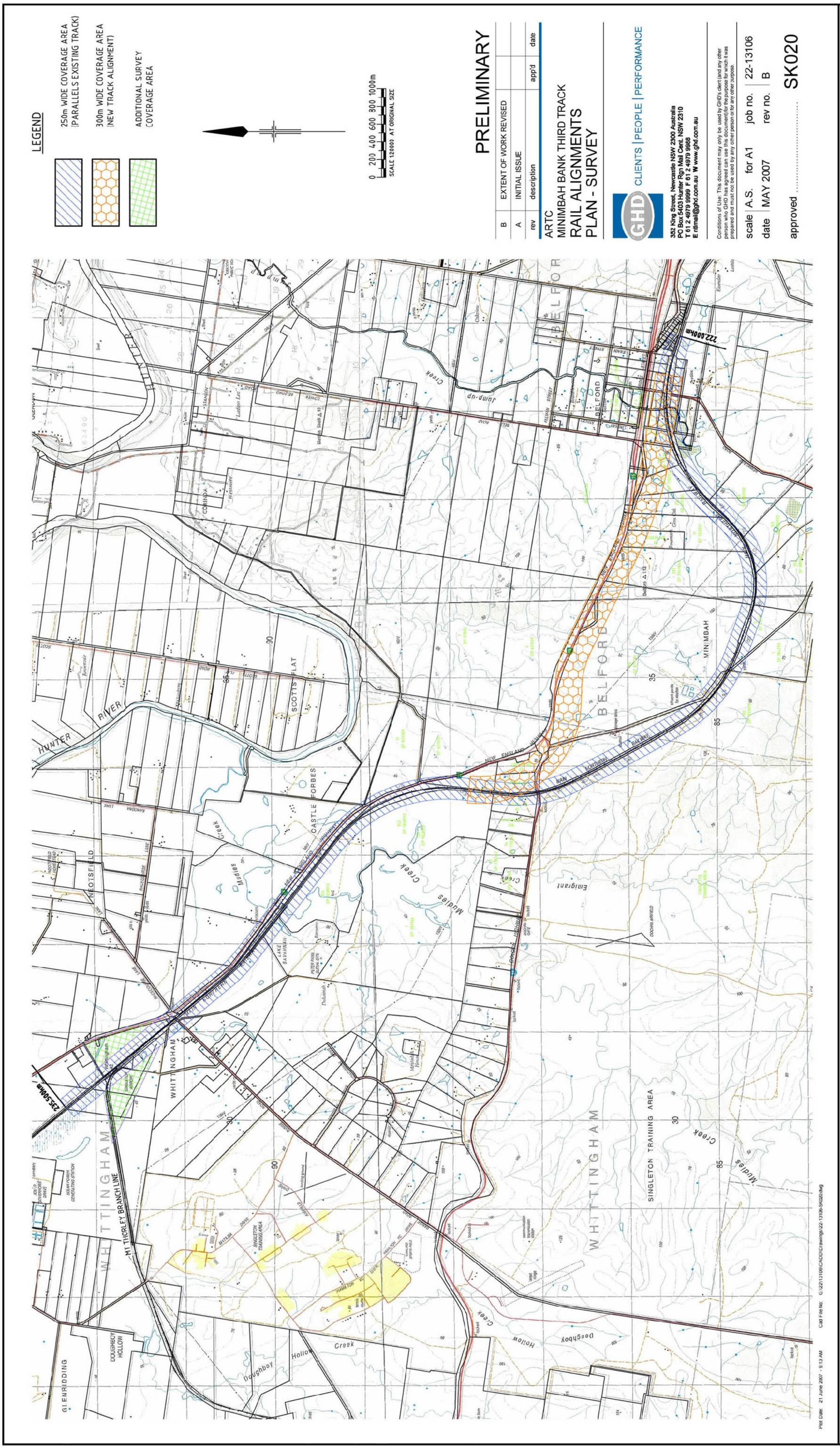

Figure 2. Layout of Proposed Alignment Options

Flora and Fauna Constraints Assessment: Proposed Third Rail Track at Minimbah Bank near Belford

November 2007

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2.0 FIRST STAGE ECOLOGICAL INVESTIGATION – PRELIMINARY ASSESSMENT

2.1 Review of Local Threatened Species and Other Records

A review of the documented records of the locations of threatened flora and fauna species within the study locality has been undertaken. Threatened species records were accessed from the Department of Environment and Climate Change (DECC) Atlas of NSW Wildlife Database for the Cessnock (9132) 1: 100 000 map sheet (updated to 28th August 2007).

2.1.1 Flora

Rare or Threatened Flora

From the review, a total of eight rare or threatened flora species are known to occur within the study locality. These are listed in **Table 2** below. Two of these, *Eucalyptus glaucina* and *Persoonia pauciflora*, are listed as threatened species by the NSW TSC Act (as Vulnerable and Endangered respectively), with *Eucalyptus camaldulensis* listed as an Endangered Population in the Act. Three species are listed in the Commonwealth EPBC Act, *Bothriochloa biloba* and *Eucalyptus glaucina* as Vulnerable and *Persoonia pauciflora* as Critically Endangered. Four additional species are not protected under State or Commonwealth legislation but are listed under the national database known as ROTAP *Rare or Threatened Australian Plants* (Briggs & Leigh 1996).

Table 2. Rare or Threatened Flora previously recorded within the Study Locality

Scientific Name	Status (TSC)	Status (EPBC)	ROTAP Risk Code	Earliest/ latest record	No. of records within 10km of site	No. of records within 2km of site
Bothriochloa biloba	U	V	3V	1968	1	0
Eucalyptus camaldulensis	E2	~	~	2006	5	3
Eucalyptus glaucina	V	V	3VCa	1904-2005	10	4
Persoonia pauciflora	E1	CE	~	1997-2005	48	0
ROTAP Only						
Acacia bulgaensis	U	~	2RC-	2002	1	0
Eucalyptus fergusonii subsp. *fergusonii*	U	~	3KC-	1999-2005	8	0
Grevillea montana	U	~	2KC-	1997-2005	49	0
Macrozamia flexuosa	U	~	2K	1999-2006	33	14

Notes:
329800E/6392100N and 338800E/6385200N are the approximate end coordinates of the subject site (Cessnock 9132 1:100000 mapsheet AGD66).
Nomenclature follows Harden (1990-1993) and Harden & Murray (2000).

Status (TSC): refers to the NSW *Threatened Species Conservation Act* 1995 (TSC)

E1	Schedule 1, Part 1: Endangered Species
E2	Schedule 1, Part 2: Endangered Populations
V	Schedule 2: Vulnerable Species
U	Unprotected (not listed in Schedule 13 of the NPW Act 1974 or in the TSC Act 1995)

Status (EPBC): refers to the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC)

CE	Critically Endangered Species
V	Vulnerable Species

ROTAP Risk Code (Briggs and Leigh 1996)

2	Geographic range in Australia less than 100km

3	Geographic range in Australia greater than 100km
V	Vulnerable Species: not presently endangered, but possibly at risk in future due to continuing depletion or land-use change
R	Rare Species: rare in Australia, but currently without any identifiable threat
K	Poorly Known: taxon that is suspected, but not definitely known, to belong to one of the above categories. At present, accurate field information is inadequate
C	Reserved: indicates taxon has at least one population within a national park, or other proclaimed conservation reserve or in an area otherwise dedicated for the protection of flora
a	1000 plants or more are known to occur within a conservation reserve(s)
-	reserved population size is not accurately known

Please note: These records are based on information supplied by the DECC and other sources, and may contain errors or omissions.

Endangered Populations of Plants

The following endangered populations of flora as listed by the *TSC Act 1995* could occur somewhere within the study locality:

- *Acacia pendula* in the Hunter catchment
- *Eucalyptus camaldulensis* in the Hunter catchment
- *Cymbidium canaliculatum* in the Hunter catchment
- *Leionema lamprophyllum* (F. Muell.) Paul G. Wilson subsp. *obovatum* F.M. Anderson in the Hunter catchment

Endangered Ecological Communities and Critical Habitat

The following endangered ecological communities as listed by the *TSC Act 1995* could occur within the study locality, and possibly in the study area if suitable habitat is available:

- Hunter lowland redgum forest in the Sydney basin and NSW north coast bioregions
- Swamp oak floodplain forest of the NSW north coast, Sydney basin and south east corner bioregions
- Swamp sclerophyll forest on coastal floodplains of the NSW north coast, Sydney basin and south east corner bioregions
- River-flat eucalypt forest on coastal floodplains of the NSW north coast, Sydney basin and south east corner bioregions
- Freshwater wetlands on coastal floodplains of the NSW north coast, Sydney basin and south east corner bioregions
- Quorrobolong scribbly gum woodland in the Sydney basin bioregion
- Warkworth sands woodland of the Sydney Basin Bioregion
- Lower Hunter spotted gum - ironbark forest in the Sydney basin bioregion
- Kurri sand swamp woodland in the Sydney basin bioregion
- White box yellow box Blakely's red gum woodland

An assessment of the likely presence of any of these ecological communities in the study area will be undertaken later in the report.

No critical habitat declared to date occurs within the study locality.

2.1.2 Fauna

Threatened Species

A total of 22 threatened terrestrial fauna species have previously been recorded within the study locality, comprising twelve bird and ten mammal species. Of these, three species (black-necked stork, swift parrot and regent honeyeater) are currently listed as endangered on Schedule 1, Part 1 of the *TSC Act 1995* and the remainder as vulnerable on Schedule 2 of the Act. Four species are also listed by the Commonwealth EPBC Act (1999), three (swift parrot, regent honeyeater and spotted-tailed quoll) as endangered and one (grey-headed flying-fox) as vulnerable. The regent honeyeater is also listed as a migratory species in the EPBC Act. The local threatened fauna species previously recorded in the locality are listed below in **Table 3.**

Table 3. Threatened Fauna previously recorded within the Study Locality

Scientific Name	Common Name	Status (TSC)	Status (EPBC)	Earliest/ latest record	Number of records within 10km of site	Number of records within 2km of site
Birds						
Callocephalon fimbriatum	Gang-gang cockatoo	V	~	2004	1	0
Calyptorhynchus lathami	Glossy black-cockatoo	V	~	1977-2001	2	0
Climacteris picumnus	Brown treecreeper	V	~	2003	1	0
Ephippiorhynchus asiaticus	Black-necked stork	E1	~	1999-2003	9	0
Grantiella picta	Painted honeyeater	V	~	1977	1	0
Lathamus discolor	Swift parrot	E1	E	2000-2002	2	0
Lophoictinia isura	Square-tailed kite	V	~	2006	1	0
Ninox connivens	Barking owl	V	~	1977	1	0
Ninox strenua	Powerful owl	V	~	1977-2004	2	1
Pomatostomus temporalis temporalis	Grey-crowned babbler (eastern subsp.)	V	~	1993-2006	32	4
Pyrrholaemus sagittatus	Speckled warbler	V	~	1992-2004	7	2
Xanthomyza phrygia	Regent honeyeater	E1	E,Mi	1977-2000	3	0
Flying Mammals						
Falsistrellus tasmaniensis	Eastern false pipistrelle	V	~	2002	1	0
Miniopterus australis	Little bent-wing bat	V	~	2001-2005	2	0
Miniopterus schreibersii oceanensis	Eastern bent-wing bat	V	~	1994-2006	10	2
Mormopterus norfolkensis	East-coast freetail-bat	V	~	1994-2006	6	1
Myotis macropus	Southern myotis	V	~	1994	1	1
Pteropus poliocephalus	Grey-headed flying-fox	V	V	2000-2004	8	0
Scoteanax rueppellii	Greater broad-nosed bat	V	~	2002-2005	2	0
Non-flying Mammals						
Dasyurus maculatus maculatus (southeastern mainland population)	Spotted-tailed quoll	V	E	1992-2005	5	1
Petaurus norfolcensis	Squirrel glider	V	~	2000-2006	11	1
Phascogale tapoatafa	Brush-tailed phascogale	V	~	1995-2006	9	0

Notes:
329800E/6392100N and 338800E/6385200N are the approximate end coordinates of the subject site (Cessnock 9132 1:100000 mapsheet AGD66).

Status (TSC): refers to the NSW *Threatened Species Conservation Act* 1995 (TSC)
E1 Schedule 1, Part 1: Endangered Species
V Schedule 2: Vulnerable Species

Status (EPBC): refers to the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC)

E	Endangered Species
V	Vulnerable Species
Mi	Migratory Species

Please note: These records are based on information supplied by the Department of Environment and Climate Change and other sources, and may contain errors or omissions.

Endangered Fauna Populations

No listed endangered populations of fauna occur within the study locality.

2.1.3 EPBC Act Protected Matters Report

The EPBC Act Protected Matters Search Tool was accessed on 15th October 2007 to identify the Protected Matters under the Commonwealth EPBC Act that occur or may occur within the study locality. This review yielded a report listing the matters that could potentially be relevant under the EPBC Act for activities within the study area. The report below identifies matters that could potentially be relevant in any part of the study locality of 10 km radius around the subject site. The species or matters listed below may not necessarily be relevant to the study area or subject site itself.

Table 4. Summary of Potentially Relevant Matters under the Commonwealth EPBC Act 1999

Protected Matter	Potentially Relevant?	Details
Matters of National Environmental Significance		
World Heritage Properties	Yes	None
National Heritage Places	Yes	None
Wetlands of International Significance (Ramsar sites)	Yes	One: Hunter Estuary Wetlands
Commonwealth Marine Areas	No	-
Threatened Ecological Communities	Yes	One: **Community likely to occur within the area according to EPBC modeling.** White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland (**CE**)
Threatened Species - Flora	Yes	Five species: **Species or species habitat may occur within area according to EPBC modeling.** *Cryptostylis hunteriana* leafless tongue-orchid (**V**) **Species or species habitat likely to occur within area according to EPBC modeling.** *Eucalyptus glaucina* slaty red gum (**V**) *Eucalyptus pumila* Pokolbin mallee (**V**) *Prostanthera cineolifera* (**V**) **Species or species habitat known to occur within area according to EPBC modeling.** *Persoonia pauciflora* North Rothbury persoonia (**CE**) The likelihood of any of these species occurring in the study area on the basis of available habitat is assessed in **Table 5** (Section 2.3.1).

Threatened Species – Fauna (Terrestrial Species only)	Yes	Thirteen species: **Species or species habitat may occur within area according to EPBC modeling.** Australian Painted Snipe *Rostratula australis* (**V**) Brush-tailed rock-wallaby *Petrogale penicillata* (**V**) Eastern long-eared bat *Nyctophilus timoriensis* (**V**) Green and golden bell frog *Litoria aurea* (**V**) Large-eared pied bat *Chalinolobus dwyeri* (**V**) Spotted-tail quoll *Dasyurus maculatus maculatus* (SE mainland population) (**E**) Swift parrot *Lathamus discolor* (**E**) **Species or species habitat likely to occur within area according to EPBC modeling.** Broad-headed snake *Hoplocephalus bungaroides* (**V**) Hastings River mouse *Pseudomys oralis* (**E**) Regent honeyeater *Xanthomyza phrygia* (**E**) Giant (southern) barred frog *Mixophyes iteratus* (**E**) Stuttering frog *Mixophyes balbus* (**V**) **Roosting known to occur within area according to EPBC modeling.** Grey-headed flying-fox *Pteropus poliocephalus* (**V**) The likelihood of any of these species occurring in the study area on the basis of available habitat is assessed in **Table 6** (Section 2.3.2).
Migratory Species (Terrestrial and Wetland Species Only)	Yes	Eleven species : **Species or species habitat likely to occur within area according to EPBC modeling.** White-bellied sea eagle *Haliaeetus leucogaster* (**Mi**) Regent honeyeater *Xanthomyza Phrygia* (**Mi, E**) **Species or species habitat may occur within area according to EPBC modeling.** Cattle egret *Ardea ibis* (**Mi**) Great egret *Ardea alba* (**Mi**) Latham's snipe *Gallinago hardwickii* (**Mi**) Painted snipe *Rostratula benghalensis s. lat.* (**Mi**) Rainbow bee-eater *Merops ornatus* (**Mi**) White-throated needletail *Hirundapus caudacutus* (**Mi**) **Breeding may occur within area according to EPBC modeling.** Black-faced monarch *Monarcha melanopsis* (**Mi**) Rufous fantail *Rhipidura rufifrons* (**Mi**) **Breeding likely to occur within area according to EPBC modeling.** Satin flycatcher *Myiagra cyanoleuca* (**Mi**) These species are discussed in **Section 4.1.2**.
Other Matters Protected by the EPBC Act		
Commonwealth Lands	Yes	Three - Commonwealth Lands identified within the study locality do not occur in the vicinity of the study area.
Commonwealth Heritage Places	No	-
Places on the Register of the National Estate	Yes (Natural places only)	One: Glendon Area NSW

Listed Marine Species	No	-
Whales and Other Cetaceans	No	-
Critical Habitats	Yes	None
Commonwealth Reserves	Yes	None
Extra Information		
State and Territory Reserves	Yes	None
Other Commonwealth Reserves	Yes	None
Regional Forest Agreements	Yes	Lower North East NSW RFA, New South Wales

Notes:
V Species listed as **Vulnerable** under the Commonwealth *EPBC Act*.
E Species listed as **Endangered** under the Commonwealth *EPBC Act*.
CE Species listed as **Critically Endangered** under the Commonwealth *EPBC Act*.
Mi Species listed as **Migratory** under the Commonwealth *EPBC Act*.

The information compiled in relation to the floral and faunal habitats of the study site has been used in the determination of a list of threatened flora and fauna species that may be regarded as potential inhabitants of the site (i.e. potential subject species). This has been undertaken in Section 2.3 below.

2.3 Determination of Local Threatened Flora and Fauna as Potential Subject Species

A list of potential subject species has been compiled. Subject species are defined as those threatened species considered likely to occur in the habitats present within the study area (NPWS 1996). Therefore, such species would be potentially impacted by the proposal.

2.3.1 Threatened Flora

An assessment of the relative likelihood of the threatened flora species previously recorded in the study locality occurring within the study area is provided below in **Table 5**.

In this report, potential subject flora species are regarded as locally-occurring species listed on the TSC Act and/or EPBC Act that are rated as having at least a moderate likelihood of occurring in the study area in Table 5 below. On this basis, one of the locally occurring threatened flora species (*Eucalyptus glaucina*) and one species that forms an endangered population locally (*Eucalyptus camaldulensis* in the Hunter catchment) could be considered potential subject species based on the available habitat and presence of previous records in the locality. Regarding species not listed by legislation, none are considered to have greater than a low to moderate likelihood of occurring in the study area.

Table 5. Assessment of the Potential for Local Rare or Threatened Flora Species to occur within the Study Area

Scientific Name	**Latest Record**	**Records Within**		**Preferred Habitat and Comments***	**Habitat available on site?**	**Potential to occur within study area**	**Subject Species**[a]
		10 km	**2 km**				
Threatened Species							
Bothriochloa biloba	1968	1	0	Woodland on poorer soils.	Possibly	**Low,** due to low record number	-
Cryptostylis hunteriana (leafless tongue orchid)	No records – DEW habitat modelling only			Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland.	Nominal habitat only	**Low,** due to lack of records	-
Eucalyptus camaldulensis (river red gum)	2006	5	3	Grassy woodland or forest on deep alluvial soils near large bodies of permanent water.	Possibly	**Moderate**	√
Eucalyptus glaucina (slaty red gum)	2005	10	4	Locally frequent but very sporadic. Grassy woodland on deep, moderately fertile and well-watered soil.	Possibly	**Moderate**	√
Eucalyptus pumila (Pokolbin mallee)	No records – DEW habitat modelling only			Currently only known from a single population west of Pokolbin where it grows on north-west facing slopes on sandstone derived soils.	Very marginal	**Low**	-

Persoonia pauciflora (North Rothbury persoonia)	2005	48	0	Dry open spotted gum/ironbark forest or woodland with a sparse shrub layer and grassy understorey. Only known from a 2.5km radius around North Rothbury.	Possibly	**Low,** due to limited distribution of species	-
Prostanthera cineolifera (Singleton mint bush)	No records – DEW habitat modelling only			Open woodland on exposed sandstone ridges. Usually associated with shallow or skeletal sands. Restricted to a few localities near Walcha, Scone and St Albans.	Possibly	**Low,** due to lack of records	-
ROTAP Only Species							
Acacia bulgaensis	2002	1	0	Restricted to the Bulga-Milbrodale-Broke area where it grows on sandstone or shale in sclerophyll forest/woodland. May become locally dominant in some exposed rocky situations and form monotypic stands.	Unlikely	**Low**	
Eucalyptus fergusonii subsp. *fergusonii*	2005	8	0	Scattered and sporadic, in wet sclerophyll forest or woodland on sandy soils.	Possibly	**Low**	
Grevillea montana	2005	49	0	Open forest in sandy soils over mixed sedimentary substrates.	Possibly	**Low**	
Macrozamia flexuosa	2006	33	14	Scattered in sclerophyll forests on siliceous soils.	Possibly	**Low to Moderate**	

Notes for Table 5
*compiled primarily from Harden (1990-2002), Harden & Murray (2000) and DECC threatened species information.
[a]Note - Species rated as having a moderate or better likelihood of occurring are regarded as potential subject species if listed by legislation. Species listed by ROTAP only are not eligible to be subject species.

2.3.2 Threatened Fauna

An assessment of the likelihood of the threatened fauna species previously recorded in the study locality occurring within the subject site is provided below in **Table 6**.

Table 6. Assessment of the Potential for Local Threatened Fauna Species to occur within the Study Area

Common Name	**Most Recent Record**	**Closest Records**		**Preferred Habitat and Comments***	**Habitat available on site**			**Potential to utilise study area**	**Subject Species**
		10 km	**2 km**		**Breeding**	**Roosting**	**Foraging**		
Birds									
Gang-gang cockatoo	2004	1	0	Tall montane forests and woodlands in summer, moving to lower altitudes in winter, preferring more open eucalypt forest and woodland, including coastal areas. Nest during the summer in trunk and limb hollows in large mature trees, often in live trees close to water.	N?	-	N?	Unlikely	-
Glossy black-cockatoo	2001	2	0	Coastal woodlands and dry eucalypt forests to open inland woodlands and forested watercourses. Requires particular food trees (She-oaks, particularly *Allocasuarina torulosa*) and large tree hollows for	N?	-	Y?	Limited potential	√

				nesting.					
Brown treecreeper	2003	1	0	Eucalypt forests, woodlands and scrubs of the drier areas, river-edge trees, timbered paddocks. Occasionally coastal plains and ranges, though predominantly found on inland plains and inland slopes of the Great Dividing Range.	N?	-	Y?	Moderate	√
Black-necked stork	2003	9	0	Inhabits permanent freshwater wetlands including margins of billabongs, swamps, shallow floodwaters, and adjacent grasslands and savannah woodlands; can also be found occasionally on inter-tidal shorelines, mangrove margins and estuaries. Feeds in shallow, still water on a variety of prey including fish, frogs, eels, turtles, crabs and snakes. Breeds in late summer in the north, and early summer further south. A large nest, up to 2 m in diameter, is made in a live or dead tree, in or near a freshwater swamp.	N	-	N	No	-
Painted honeyeater	1977	1	0	Dry forest and woodland. Primarily feeds on fruit of Mistletoe *Amyema* spp., also nectar and insects. Most common on the western slopes and plains. The habitat on site is marginal for this species.	N	-	Y?	Potential seasonal visitor	√
Swift parrot	2002	2	0	The migratory nature of these species makes them difficult to assess. Known to frequent sclerophyll forest and woodlands with winter flowering trees (eg. spotted gum, red ironbark, *Eucalyptus crebra* and *E. siderophloia*, forest red gum and swamp mahogany) on an opportunistic basis along the coast and ranges of NSW. The habitat on site is marginal for this species.	N	-	Y?	Potential seasonal visitor	√
Square-tailed kite	2006	1	0	Specialised canopy predator, feeding on small birds, eggs and insects. Primarily hunts over open forest, woodlands and mallee communities that are rich in passerines, as well as over adjacent heaths and other low scrubby habitats and in wooded towns. Appears to prefer a structurally diverse landscape.	?	?	Y	Potential foraging	√
Barking owl	1977	1	0	Open forests, woodlands, dense scrubs, foothills and paperbark swamps. Favours dense creeklines with river red gums and other large trees in open country. Feeds on a variety of vertebrate and invertebrate fauna. Requires large hollows for nesting.	N?	N?	Y	Limited potential (foraging only)	√
Powerful owl	2004	2	1	Occurs in open forest and woodland, roosting in dense tree foliage, often in riparian situations. Prefers well developed tall forest with large tree hollows for nesting. Feeds on possums, gliders, birds and fruit-bats.	N?	N?	Y	Moderate	√
Grey-crowned babbler	2006	32	4	Open eucalypt woodlands with a grassy groundcover and sparse, tall shrub layer. May also be observed along streams in cleared areas and grassy road verges. Conspicuous large communal nests/roosts are constructed out of twigs. Raucous groups of 2-13 individuals foraging for insects in all substrates.	Y?	-	Y	High	√
Speckled warbler	2004	7	2	Open timbered eucalypt woodlands, preferably where ground cover consists of grass, fallen leaves and bark. This species forages on insects and small seeds.	Y?	-	Y	High	√
Regent honeyeater	2000	3	0	Box-ironbark eucalypt associations, though uses other woodland types and wet lowland coastal forest in times of food shortage. The wandering nature of this species	N	-	Y?	Potential seasonal visitor	√

				makes it difficult to assess. Known to frequent areas with densely blossoming winter-flowering trees (eg. Spotted Gum, Red Iron bark, Forest Red Gum and Swamp Mahogany) on an opportunistic basis along the coast and ranges of NSW.					
Australian painted snipe	No records – DEW habitat modelling only			Permanent and temporary shallow inland and coastal wetlands (can be freshwater or brackish), particularly where there is a cover of vegetation. Individuals have been known to use artificial wetlands (such as sewage ponds, dams and water-logged grasslands).	N	-	N	No	-
Masked owl	No records – DEW habitat modelling only			Predominantly forages for terrestrial prey, such as rats and small rabbits within a mosaic of open woodland/forest habitats and on the edge of cleared land. Roosts and nest in large tree hollows although will also roost in dense vegetation and caves.	Y?	Y?	Y	Moderate	√
Black-chinned honeyeater	No records – DEW habitat modelling only			Dry eucalypt savannah woodland and forest with an annual rainfall range of 400-700mm, particularly with box-ironbark associations and River Red Gums. Considered to be locally nomadic requiring remnants of greater than 200ha in area. Forages within foliage and bark of eucalypt trees on spiders, insects, lerp and nectar.	Y?	-	Y	Moderate	√
Turquoise parrot	No records – DEW habitat modelling only			Open eucalypt woodland or forest with a grassy or sparsely shrubby understorey. Favours grasslands on the edge of these habitat types, particularly timbered grassland on mountain slopes and ridges. Feeds on seeds of native and introduced grasses and other herbs. Requires suitable hollows in tree limbs, logs or fence posts for breeding.	Y?	-	Y	Moderate	√
Diamond firetail	No records – potential habitat occurs within the locality			Open forest with a grassy groundcover, woodland, mallee, acacia scrub lands and timber belts along watercourses and roadsides.	Y?	-	Y	Moderate	√
Hooded robin	No records – potential habitat occurs within the locality			Prefers open areas adjacent to large blocks of woodland, particularly with areas of dead timber and sparse shrub cover. Also recorded in open forests and acacia shrublands.	Y?	-	Y	Moderate	√
Grass owl	No records – potential habitat occurs within the locality			Found in areas of tall grass, including swampy areas, grassy plains and heath. Also found in areas of tall sedges on floodplains. Roost and nest on trampled down platforms of grass.	Y?	-	Y	Moderate	√
Flying Mammals									
Eastern false pipistrelle	2002	1	0	Tall forest, woodland or heath/ grassland edges. Observed to roost in the hollow trunks of the largest trees and sometimes buildings.	N?	N?	?	Unlikely	-
Little bentwing-bat	2005	2	0	Forages in a range of habitats, including forest, woodland, heath, coastal swamps and rainforest. A nightly foraging range of 20km from roost sites has been reported. Reliant on suitable roosting habitat in caves and mine tunnels, though has been recorded roosting in hollowed out tree bases and dense foliage.	N	Y	Y	Moderate	√
Eastern bentwing-bat	2006	10	2	Forages within a variety of habitat types including moist and dry eucalypt forest, woodland, rainforest, heath and open environments, including urban areas. Reliant on suitable roosting/breeding habitat in caves and mine tunnels, though will also roost in stormwater	N	Y	Y	High	√

				channels, road culverts and other comparable structures (including buildings). Estimated nightly foraging range of 20+ km.					
East-coast freetail-bat	2006	6	1	The habitat preference of this species is unclear. It has been predominantly recorded in dry eucalypt forest and woodland, but has been recorded in moist and edge environments. The wing morphology indicates that this species is adapted to more open habitats or above the tree canopy. This species primarily roosts in tree hollows, although the roofs of buildings are also used.	Y?	Y	Y	Moderate	√
Southern myotis	1994	1	1	Habitats adjacent to large bodies of water for hunting aquatic insects. Usually forages over or adjacent to water-bodies and associated terrestrial habitats. Roosts in caves, mines, tunnels, bridges, culverts and tree hollows.	N	Y	Y	Moderate	√
Grey-headed flying-fox	2004	8	0	Regularly occurs along the eastern coastal plain through NSW. Roosts in camps, usually in dense riparian habitats. At dusk disperses in search of the preferred food source, mainly Eucalypt blossom and rainforest fruits. Long distances are covered (30+km) in search of food.	N	N	Y	High (foraging only)	√
Greater broad-nosed bat	2005	2	0	Forages for insects over a range of natural and altered habitats, including tall forest, woodland or heath/grassland edges, often along the tree line boundary. Prefers tree hollows in large, often isolated, mature trees for roosting. Usually associated with tall moist open forest.	Y?	Y	Y	Moderate	√
Eastern long-eared bat	No records – DEW habitat modelling only			Eastern long-eared bat roost in tree hollows and fissures. On the mainland, this species is known from tall eucalypt forest as well as mallee, open savanna and black box woodland. Appear to have a preference for semi-arid areas.	Y?	Y?	Y?	Unlikely	-
Large-eared pied bat	No records – DEW habitat modelling only			Range of well-wooded habitats, including dry sclerophyll forests and woodlands of coastal and semi-arid areas. Occasionally in sub-alpine woodlands and at the edge of rainforest and semi-arid areas. Reliant on suitable roosting habitat including caves and mine tunnels (though may use other structures, eg. abandoned Fairy Martin nests).	N	N	N?	Unlikely	-
Yellow-bellied sheathtail-bat	No records – DEW habitat modelling only			Wide range of habitats, including open forest. Forages above the canopy in wooded areas and lower down in more open areas or along creeklines. Reliant on suitable trees with hollows for roosting.	Y?	Y	Y	Moderate	√
Non-flying Mammals									
Spotted-tailed quoll	2005	5	1	Inhabits a variety of habitat types from moist and wet sclerophyll through to dry forests and woodlands on the edge of open grasslands. Requires large hollowed logs on the ground for den sites. Use a large home range within extensive areas of bushland.	N	-	Y?	Limited potential	√
Squirrel glider	2006	11	1	Usually inhabits dry open sclerophyll forest and woodlands, but has also been observed in moist regenerating forest and moist gullies. Forages on Acacia gum, Eucalypt sap, nectar, honeydew, manna invertebrates and pollen, utilising areas with an abundance of flowering eucalypts and tall shrubs (eg.	Y?	Y?	Y	High	√

				Banksias). Acacia species are the preferred sap feeding trees. This species requires an abundance of suitably sized hollow-bearing trees.					
Brush-tailed phascogale	2006	9	0	Found in dry sclerophyll open forests and woodlands, with a preference for sparse ground cover. Also inhabits heath, swamps, rainforest and wet sclerophyll forest. Requires large areas of intact habitat. Nests and shelters in tree hollow.	Y?	Y?	Y?	Moderate	√
Brush-tailed rock-wallaby	No records – DEW habitat modelling only			Rock-wallabies are restricted to rock outcrops containing suitable caves and tunnels within rock boulders for daytime shelter. Forage on grasses and herbs in adjacent forests/woodlands and farmland. Limited foraging areas occur on site and 2km from known cliff habitat	N	N	N	No	-
Hastings River mouse	No records – DEW habitat modelling only			Known from habitat near creeklines within open eucalypt forest with dense ground cover of sedges, grasses and/ or ferns.	N	N	N	No	-
Koala	No records – some preferred food trees occur			Forest and woodland habitats that contain suitable regional eucalypt feed trees. In the locality, the forest red gum, grey gum and scribbly gum are listed food trees in SEPP 44.	?	-	Y	Limited potential	√
Reptiles									
Broad-headed snake	No records – DEW habitat modelling only			Broad-headed snakes are restricted to sandstone outcrops and escarpments, where they shelter in caves or under rock slabs on rock and in near by tree hollows during summer. These snakes forage on lizards, skinks and geckos.	N	-	N	No	-
Frogs									
Green and golden bell frog	No records – DEW habitat modelling only			Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.). Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as plague minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available. Some sites, particularly in the Greater Sydney region occur in highly disturbed areas. The species is active by day and usually breeds in summer when conditions are warm and wet. Males call while floating in water and females produce a raft of eggs that initially float before settling to the bottom, often amongst vegetation. Tadpoles feed on algae and other plant-matter; adults eat mainly insects, but also other frogs. Preyed upon by various wading birds and snakes.	N?	-	N?	Limited potential	√
Giant (southern) barred frog	No records – DEW habitat modelling only			Giant barred frogs forage and live amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m. They breed around shallow, flowing rocky streams from late spring to summer. Females lay eggs onto moist creek banks or rocks above water level, from where tadpoles drop into the water when hatched. Tadpoles grow to a length of 80 mm and take up to 14 months before changing into frogs. When not breeding the frogs disperse hundreds of metres away from streams. They feed primarily on large insects and spiders.	N	N	N	No	-

Stuttering frog	No records – DEW habitat modelling only	Terrestrial inhabitants of rainforest, Antarctic beech or wet sclerophyll forest along permanent streams.	N	N	N	No	-

*Compiled from: Australian Museum Fact Sheets; Barrett et al. 2003; Churchill, 1998; Cogger, 1995; Garnett & Crowley, 2000; DECC threatened species information; Stanger et al, 1997; Strahan, 1995.
√ most potential to occur and therefore a potential subject species.
? it is uncertain, though considered unlikely that suitable habitat may be available.

Of the 39 threatened fauna species assessed in the above table, 28 are considered to be potential or likely subject species and these are listed in **Section 2.3.3** below.

2.3.3 Potential Threatened Species, Endangered Populations and Endangered Ecological Communities to be assessed

The following statutory-listed species and ecological communities that were considered to have at least a moderate likelihood of occurrence in **Section 2.3.1** and **2.3.2** above are considered to have potential to occur within the study area and are considered to be potential subject species in this assessment. Species that were rated as having a "low to moderate" or lower likelihood of occurring are not included. Migratory species are discussed under the EPBC Act in **Section 4.1.2**.

Flora

Eucalyptus glaucina – slaty red gum (Vulnerable – TSC and EPBC Acts)
Eucalyptus camaldulensis – river red gum (Endangered Population in the Hunter Catchment)

Fauna

The following threatened species have potential to at least forage within the study area;

- Glossy black cockatoo
- Black-chinned honeyeater
- Barking owl
- Masked owl
- Square-tailed kite
- Speckled warbler
- Turquoise parrot
- Hooded robin
- Eastern bentwing-bat
- Greater broad-nosed bat
- Southern myotis
- Grey-headed flying-fox
- Squirrel glider
- Koala
- Brown treecreeper
- Painted honeyeater
- Powerful owl
- Swift parrot
- Grey-crowned babbler
- Regent honeyeater
- Diamond firetail
- Grass owl
- Little bentwing-bat
- East-coast freetail-bat
- Yellow-bellied sheathtail-bat
- Spotted-tailed quoll
- Brush-tailed phascogale
- Green and golden bell frog

Endangered Ecological Communities

- Hunter lowland redgum forest
- River-flat eucalypt forest on coastal floodplain
- Swamp-oak floodplain forest
- Swamp sclerophyll forest on coastal floodplain
- Freshwater wetlands on coastal floodplains

- Lower Hunter spotted gum - ironbark forest
- White box yellow box Blakely's red gum woodland

Field survey techniques were designed to adequately target these subject species, populations and ecological communities and are discussed in **Section 3**. The potential impacts on these subject species and communities as a result of the different potential route options are presented in **Section 4** of this report.

3.0 SECOND STAGE ECOLOGICAL INVESTIGATION – FIELD SURVEYS

3.1 Floral Investigations

3.1.1 Methodology

A flora field survey was undertaken from within the accessible parts of the study area on the 30th October 2007. The survey was undertaken along a transect within the railway easement by driving along the parallel service track and recording general vegetation types and vegetation condition in each area. Frequent stops were made where remnants of natural vegetation or other flora features of interest occurred and more detailed surveys undertaken on foot in these areas. Grid references were taken with a hand-held GPS of points where changes in vegetation types occurred or any significant flora features were detected.

The possible presence of any rare or threatened flora species was also considered during the survey, with particular attention paid to areas of suitable habitat for each of the subject flora species. Surveys within the road easement for the deviation option were undertaken in a similar manner, utilising public service roads and tracks parallel to the New England Highway.

For each option, access to the road and railway easements only were possible and surveys of vegetation types and species for the parts of the study area on private land were restricted to remote viewing of these areas from within the easements (see Survey Limitations under the next heading).

The survey methods were thus not complaint with current best practice Flora Survey Guidelines for a full impact assessment, such as those endorsed by local councils in the Lower Hunter area (LHCCREMS 2002). Normally, in addition to a prescribed number of transects on foot though the site depending on its area, a prescribed number of 400 m^2 quadrats would be examined per vegetation community. However, because of the narrowness and generally cleared, weedy nature of the part of the study area that was accessible; no formal flora quadrats were established. The flora survey methods were considered to be appropriately detailed for a constraints/route options assessment, given the access limitations.

Small samples of any plant species that could not be identified in the field were obtained for further examination and identification, particularly any species that may be threatened or significant (if such specimens could be obtained).

3.1.2 Survey Limitations

The flora survey could only be conducted from within the railway easement itself and from within the highway easement for the deviation option (Option 1). No private property could be accessed in any part of the designated study area. Therefore, identification of vegetation communities and dominant species in these areas could only be undertaken remotely via ‘over the fence’ observations and sometimes by extrapolation of the adjacent vegetation type within the easement. Consequently, some assumptions have been made as to the likely vegetation communities that occurred within the parts of the study area in private property and the exact identification of some flora species in these areas was uncertain. Additionally, lower species numbers overall (particularly for shrub and ground layers) were recorded than if the areas could have been accessed.

3.1.3 Results

Vegetation Communities

Three broad natural vegetation community types and two artificial or cultivated vegetation community types were found to occupy the study area:

Natural Communities

1. Ironbark - Spotted Gum – Grey Box Woodland / Open Forest
2. Forest Red Gum – Grey Box Woodland / Open Forest
3. Forest Red Gum – Swamp Oak Riparian Forest

Artificial Communities

4. Plantations / Vineyards
5. Derived Open Pasture – Grassland / Weedy areas

Distributions of the vegetation communities are shown in **Figure 3** and descriptions of the structure and floristics of the natural communities within the site are given in **Table 7**.

Comparison with Regional Vegetation Mapping

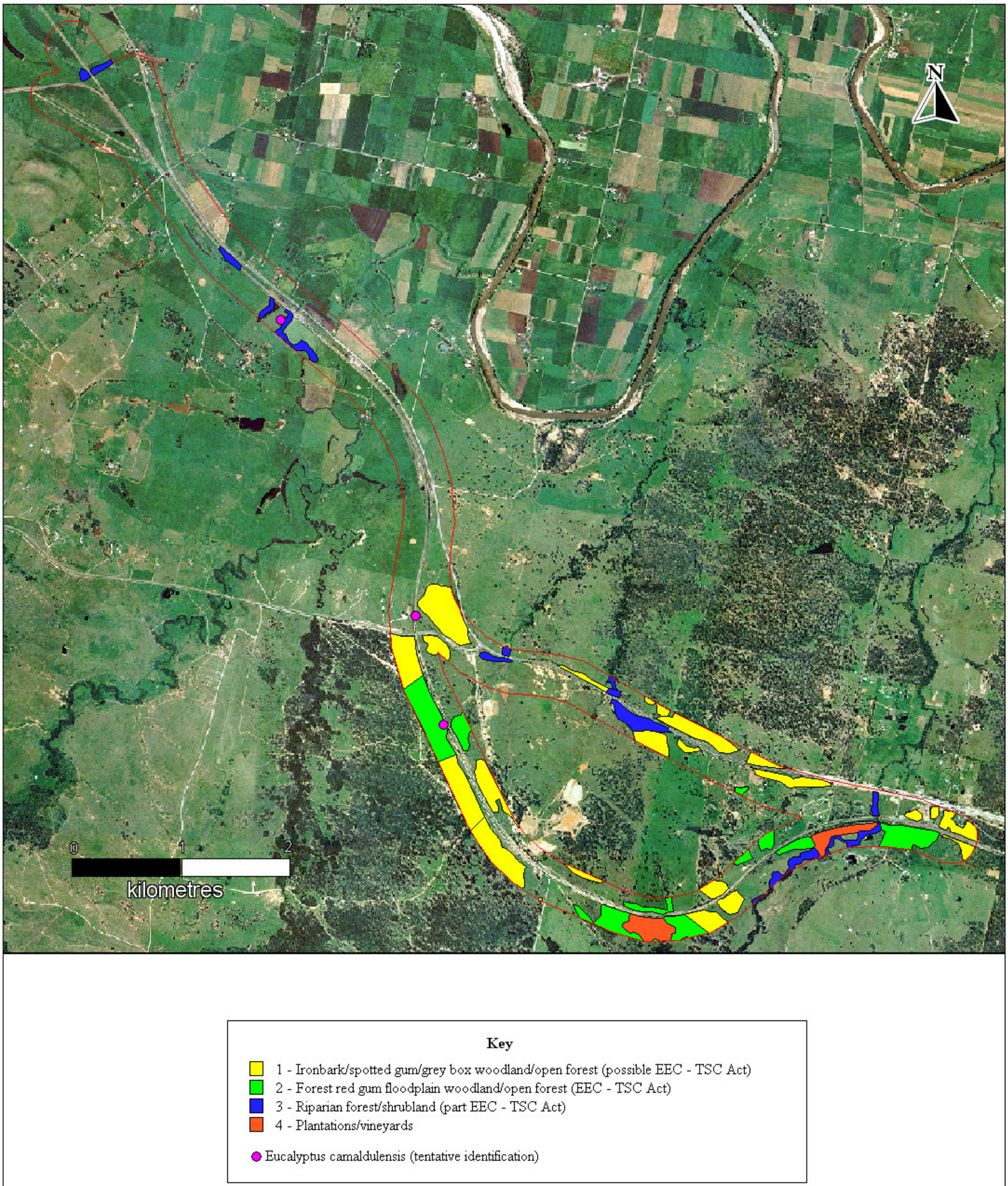
The regional mapping of vegetation in the Central Hunter Valley for the Hunter Remnant Vegetation Project (Peake 2006) shows the remnant vegetation occurring within the study area as comprising four Map Units:

- MU 24: Hunter Lowlands Redgum Forest
- MU 27: Central Hunter Ironbark – Spotted Gum – Grey Box Forest
- MU 28: Central Hunter Swamp Oak Forest
- MU 30: Hunter Valley River Oak Forest

The regional mapping appears to be broadly correct for the study area at the scale at which it was done, but individual patches from this study may be classified slightly differently due to the finer scale at which this study was undertaken. One major difference is that the regional mapping shows River Oak Forest as occurring along Jump-Up Creek at the eastern end of the study area, but no river oaks were recorded in the current study, possibly because of access limitations to that part of the creek.

The HRVP Map Units that are considered to most closely correspond to the vegetation units from this study are as follows:

- Community 1 – MU 27
- Community 2 – MU 24
- Community 3 – MU 28 with elements of MU 24 and possibly MU 30
- Communities 4 and 5 – Shown as blank



Aerial Photo Source: NSW Department of Lands SIX Viewer www.maps.nsw.gov.au

Ecotone Ecological Consultants Pty Ltd

Figure 3. Vegetation Communities & Threatened Flora

Flora and Fauna Constraints Assessment: Proposed Third Rail Track at Minimbah Bank near Belford	November 2007

Table 7. Descriptions of the vegetation communities within the study area

Stratum	Height	% cover*	Dominant species	Comments
Community 1: WOODLAND / OPEN FOREST: Ironbark - Spotted Gum - Grey Box				
Tree layer	20 – 25 m	15 – 30	*Corymbia maculata* *Eucalyptus crebra* *E. paniculata* *E. moluccana*	Habitat: Well-drained slopes and more elevated areas, including ridgetops. Structure/Characteristics: Woodland to open forest dominated by species adapted to or tolerant of drier or well-drained conditions. Distribution within Study Area: A number of discontinuous remnants collectively accounting for the largest area of natural vegetation within the study area, from the Golden Highway overpass/intersection in the west to the eastern limit of the study area. Condition & Presence of Weeds: Most patches of the community are generally in a modified condition, with varying degrees of clearing and/or underscrubbing. The level of weed invasion is generally low, apart from edge areas. Conservation Status: Although small patches of the community could qualify for the EEC 'Lower Hunter spotted gum - ironbark forest', the regional vegetation mapping (Peake 2006) shows the western limit of the map unit that corresponds to the EEC as occurring to the east of the study area. Therefore, most or all of this community is not likely to be an EEC.
Shrub layer	1 – 3 m	0 – 30	*Acacia falcata* *Cassinia aculeata* *Ozothamnus diosmifolius* *Pultenaea spinosa*	
Ground layer	To 1 m	20 – 50	*Austrodanthonia* sp. *Cheilanthes sieberi* *Dichelachne micrantha* *Tricoryne elatior* *Chrysocephalum apiculatum* *Enchylaena tomentosa* *Eremophia debilis* *Geranium* spp. *Lachnagrostis filiformis* *Lomandra filiformis* *L. multiflora* *Themeda australis* *Vernonia cinerea* *Wahlenbergia communis*	
Climbers/ Twiners	-	-	*Glycine tabacina* *Hardenbergia violacea*	
				

*projective foliage canopy cover

continued . . .

Table 7, continued . . .

Stratum	**Height**	**% cover***	**Dominant species**	**Comments**
Community 2: WOODLAND / OPEN FOREST: Forest Red Gum – Grey Box				
Tree layer	20 – 25 m	15 – 30	*Eucalyptus tereticornis* *E. moluccana*	Habitat: Lower slopes, low lying gully and upper floodplain areas with restricted drainage adjoining riparian areas. Structure/Characteristics: Woodland to open forest dominated by species adapted to or tolerant of moister or poorly-drained conditions. Distribution within Study Area: Occurs as a set of discontinuous patches tending to alternate with Community 1 depending on topography, east from the Golden Highway overpass/intersection to the eastern end of the study area. Condition & Presence of Weeds: Most patches of the community are generally in a modified condition, with varying degrees of clearing and/or underscrubbing. The level of weed invasion is generally low, apart from edge areas. Conservation Status: The habitat of the community together with the particular assemblage of species according to the Final Determination (NSW Scientific Committee 2002) indicates that the community qualifies as the EEC 'Hunter lowland redgum forest' under the NSW TSC Act.
Sub-canopy layer	6 – 12 m	0 – 20	*Allocasuarina littoralis*	
Shrub layer	2 – 5 m	5 – 30	*Exocarpus cupressiformis* *Jacksonia scoparia* *Acacia falcata* *A. irrorata*	
Ground layer	To 1 m	30 – 60	*Austrodanthonia* sp. *Cheilanthes sieberi* *Chrysocephalum apiculatum* *Cynodon dactylon* *Dichondra repens* *Geranium* spp. *Lachnagrostis filiformis* *Poa labillardierei* *Themeda australis* *Vernonia cinerea* *Wahlenbergia communis*	
Climbers / Twiners	-	-	*Polymeria calycina* *Glycine tabacina* *Marsdenia rostrata*	
				

*projective foliage canopy cover

continued . . .

Stratum	Height	% cover*	Dominant species	Comments
Community 3: RIPARIAN FOREST: Forest Red Gum – Swamp Oak				
Tree layer	0 – 25 m	0 – 40	*Eucalyptus tereticornis* *Angophora floribunda*	Habitat: Lower floodplains, banks and shallow water/ fringe areas of major creeks and watercourses. Structure/Characteristics: Forest to open forest or sedgeland without trees associated with major streams and watercourses. Dominated by trees and/or shrubs adapted to or tolerant of wet or waterlogged conditions. Paperbarks, swamp oaks, sedges, reeds, rushes and aquatic plants common. Distribution within Study Area: Occupies small areas directly associated with creeks and watercourses, mainly in the eastern part of the study area. Condition & Presence of Weeds: The community has been modified to varying degrees by clearing and underscrubbing in parts, and is partially invaded by weeds Conservation Status: The habitat of the community together with the particular assemblage of species according to the Final Determinations indicates that the community qualifies either as the EEC 'River-flat eucalypt forest on coastal floodplains' (NSW Scientific Committee 2004a) where eucalypts are dominant or 'Swamp oak floodplain forest' (NSW Scientific Committee 2004b) where swamp oaks are dominant.
Sub-canopy layer	5 – 15 m	0 – 75	*Casuarina glauca* *Acacia irrorata* *Melaleuca linariifolia*	
Shrub layer	1 – 2 m	10 - 90	*Bolboschoenus caldwellii* *Dianella caerulea* *Eleocharis cylindrostachys* *Persicaria hydropiper* *Phragmites australis* *Typha orientalis*	
Ground layer	To 1 m	30 – 80	*Asperula conferta* *Commelina cyanea* *Cheilanthes sieberi* *Cynodon dactylon* *Dichondra repens* *Geranium solanderi* *Pennisetum clandestinum* *Rubus fruticosus*	
Aquatic plants	Water surface	-	*Azolla filiculoides* *Marsilea hirsuta* *Spirodela punctata* *Triglochin procerum*	
Vines / twiners	-	-	*Clematis aristata* *Glycine tabacina*	
				

*projective foliage canopy cover

continued . . .

Table 7, continued . . .

<table>
<tr><th colspan="2">Community 4: Plantations / Vineyards</th></tr>
<tr><td colspan="2">This community occurs in two locations within the study area, both to the south of the existing railway line. One olive plantation occurs at about the southern limit of the study area; and a vineyard occupies an area adjoining Jump Up Creek near the eastern end of the study area west of Hermitage Road. The community has no floristic conservation value.</td></tr>
<tr><th colspan="2">Community 5: Derived Open Pasture – Grassland / Weedy areas</th></tr>
<tr><td>In total, this community occupies the largest portion of the study area. It is the predominant community in the western half of the study area and consists of either grazed pasture composed of exotic or native pasture grasses and minor herbs; or derelict weedy areas from which trees and shrubs have generally been cleared. Most of the area within the railway easement is characterised by the latter form, whilst private grazing land characterises the derived open pasture form. The community has no floristic conservation value, but could provide habitat for certain native fauna species, particularly birds.</td><td></td></tr>
</table>

Floral Diversity

Flora species diversity was found to be moderate within the study area, with 145 flora species from 62 families being identified. This total included three ferns, one conifer, 102 dicotyledons and 39 monocotyledons. However, the majority of the flora was exotic. Of the total species recorded, 75 species of introduced flora were identified, representing approximately 52% of the total species. As discussed under Survey Limitations (section 3.1.2) floral diversity was essentially a reflection of species within the railway and highway easements.

A list of all flora species recorded and identified from within the study area is included as **Appendix 1**.

Condition of the Vegetation and Presence of Weeds

The vegetation within the railway easement part of the study area in particular is highly cleared, in poor condition and very weedy. Very little natural vegetation remains in this area. Native vegetation is restricted to trees, swamp or riparian species and robust native shrub and ground layer species. In particular, the western section of the study area (generally west of the Golden Highway crossing) is the most highly cleared and disturbed with very little if any native vegetation remaining in this section. Native vegetation in the eastern section is mainly restricted to partially cleared and/or under-scrubbed remnants subject to grazing and other disturbances. Possibly the most intact areas of native vegetation occur within the Singleton Army Training Area and in riparian areas along major creeks such as Jump-Up Creek.

All vegetation within the railway and highway easements is subject to frequent modification in the form of easement maintenance, and is subject to constant edge effects, including nutrient-rich runoff and dispersal of weed seeds by transport activities.

Seven of the species recorded in the study area are declared Noxious Weeds in the Upper Hunter County Council control area, pursuant to the *Noxious Weeds Act 1993*. These, together with their relevant control classes, are:

- Annual ragweed (*Ambrosia artemisiifolia*) – Class 5
- Bathurst burr (*Xanthium spinosum*) – Class 4
- Blackberry (*Rubus fruticosus* sp. aggr.) – Class 4
- Mother of millions – (*Bryophyllum delagoense*) – Class 3
- Paterson's curse – (*Echium plantagineum*) – Class 4
- Common prickly pear (*Opuntia stricta* var. *stricta*) – Class 4
- Sweet briar (*Rosa rubiginosa*) – Class 4

Explanations of the relevant control categories are as follows:

Class 3: The plant must be fully and continuously suppressed and destroyed.
Class 4: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority. Management plans for most of the above weeds and general advice about control of all Class 4 noxious weeds in the Upper Hunter County Council control area is available from the website for the Upper Hunter Weeds Authority at http://www.muswellbrook.nsw.gov.au/Weeds/index.html
Class 5: The requirements in the *Noxious Weeds Act 1993* for a notifiable weed must be complied with. See **Appendix 3** for further details.

Most of the noxious weeds identified had a trace presence within the subject site only or were present in very restricted areas within the site.

Apart from declared noxious species, common or established environmental weed species within the subject site include galenia, fennel, narrow-leaf cotton bush, cobblers pegs, skeleton weed, spear thistle, variegated thistle, fire weed, madeira vine, hairy brassica, common peppercress, honeysuckle, caustic weed, castor oil plant, common melilot, wall fumitory, redflower mallow, paddy’s lucerne, large-leaved privet, purpletop, onion weed, trad, paspalum, kikuyu and coolatai grass. Some of these weed species occur at locally high densities, but most are generally restricted in their distribution throughout the site or occur at low density. Control of any of these species is desirable.

Threatened or Significant Flora Species, Endangered Populations and Endangered Ecological Communities

No threatened flora species listed under the NSW TSC Act 1995 or the Commonwealth EPBC Act 1999 were recorded within the study area. It is possible that the slaty red gum (*Eucalyptus glaucina* – TSC and EPBC Acts: Vulnerable) could occur in the private property outside the easement, and that some trees observed from a distance and interpreted as the superficially similar forest red gum (*Eucalyptus tereticornis*) could be this species. According to Peake (2006), slaty red gum may be sub-dominant in the Belford district through to the Singleton Military Area.

One species that forms an Endangered Population in the Hunter catchment, river red gum (*Eucalyptus camaldulensis*), was tentatively recorded in three locations in adjoining private land near the easement boundary during the field survey (**Figure 3**), all to the south of the railway easement. Additional occurrences of the species may be present within private property further away from the easement boundary. According to the DECC Wildlife Atlas, *Eucalyptus camaldulensis* has previously been recorded south of the western end of the study area near the Singleton landing ground, between Mt Thorley branch line and Range Road.

In terms of Endangered Ecological Communities, the following may occur within the study area subject to further detailed flora survey work within the parts of the study area in private property:

1. Lower Hunter spotted gum – ironbark forest. Vegetation Community 1 from this study is dominated by various combinations of spotted gum, ironbarks and grey box. The regional vegetation study of Peake (2006) shows Map Unit 26 (Lower Hunter Spotted Gum – Ironbark Forest), which is included in this EEC, as not extending as far west as Belford. Locally, this community is replaced by Map Unit 27 (Central Hunter Ironbark – Spotted Gum – Grey Box Forest), which is not part of the EEC (NSW Scientific Committee 2005). It is possible that parts of the spotted gum – ironbark forest association (Community 1) within the study area could qualify as the EEC. Narrow-leaved ironbark (*Eucalyptus crebra*) and grey box (*E. molucanna*) become more abundant in MU 27, and red ironbark (*E. fibrosa*) generally becomes less dominant (Peake 2006). This generally appears to be the case for Community 1 within the study area. Therefore, although it is considered that the EEC probably does not occur within the study area, small patches of vegetation that could qualify as the EEC may occur within the study area. This would need to be confirmed by further survey work in adjoining private properties.
2. Hunter lowland redgum forest. Vegetation Community 2 appears to broadly correspond to the listed EEC according to the Final Determination (NSW Scientific Committee 2002). Small patches of Map Unit 24 (Hunter Lowlands Redgum Forest) are shown by the regional mapping of the Central Hunter (Peake 2006) as occurring at the eastern end of the study area, usually associated with creeks and floodplains. This community is mainly restricted to the eastern end of the study area.
3. River-flat eucalypt forest. Narrow strips of this EEC appear to occur along the banks and floodplain of Jump Up Creek. This EEC is not listed as occurring within the study area for the Hunter Remnant Vegetation Project (Peake 2006); however the Final Determination for the EEC (NSW Scientific Committee 2004a) states that this EEC is known from parts of Singleton LGA.
4. Swamp-oak floodplain forest. Patches of this EEC are considered to occur within the study area in a gully south of the New England Highway, approximately in the middle of the deviation option (Option 1). These patches are shown in the regional vegetation mapping for the Central Hunter (Peake 2006) as Map Unit 28 (Central Hunter Swamp Oak Forest). Very small patches of this EEC also appear to occur by the railway easement near the western end of the study area between Range Road and Mudies Creek. These patches are not shown on the regional mapping, presumably because of their small size. This EEC is not listed as occurring within the study area for the Hunter Remnant Vegetation Project (Peake 2006); nor is it stated as being known from the Singleton LGA in the Final Determination for the EEC (NSW Scientific Committee 2004b). However, it is known to occur in the adjoining Cessnock LGA and the Final Determination states that it could occur elsewhere in the Sydney Basin Bioregion.

Therefore, from this preliminary assessment, it appears that at least three EECs listed under the NSW TSC Act 1995 occur within the study area – *Hunter lowland redgum forest, river-flat eucalypt forest* and *swamp-oak floodplain forest.* It is possible that minor elements of a fourth EEC, *Lower Hunter spotted gum-ironbark forest*, may occur within the study area but this would need to be clarified during a more detailed flora survey within the parts of the study area in private property.

No additional endangered ecological communities listed under either the TSC Act or EPBC Act are considered to be relevant to the study area.

Overall Significance of the Vegetation

The vegetation within the study area is significant primarily because some communities qualify as EECs, but also because it contains and provides habitat for the river red gum, *Eucalyptus camaldulensis* which is an endangered population under the NSW TSC Act.

The main ecological function of the remnant vegetation in the study area is as part of a system of corridors that provide connectivity both for movement of fauna and for exchange of genetic material between native flora species locally. This would tend to reduce the risk of local flora populations becoming isolated.

3.2 Faunal Investigations

3.2.1 Methodology

A fauna field habitat assessment was undertaken from within the accessible parts of the study area on the 30th October 2007. The survey was undertaken along a transect within the railway easement by driving along the parallel service track and recording information about the available fauna habitat, focusing on the potential for threatened species to occur within the area. Frequent stops were made at watercourses, areas of remnant vegetation and other potential fauna habitat features to investigate these locations on foot. Grid references were taken with a hand-held GPS (5-10m accuracy) where potential habitat for threatened fauna species was observed to occur, including areas containing potential habitat trees or bat roosts. Surveys within the road easement for the deviation option were undertaken in a similar manner, utilising public service roads and tracks parallel to the New England Highway.

All opportunistic observations of fauna or faunal activity were recorded during the survey, including visual and auditory recognition of fauna species and recognition of evidence of faunal activity (eg. diggings, scratch marks, droppings).

For each option access was limited to the road and railway easements and for those parts of the study area on private land the field assessment was restricted to remote viewing from within the easements (see Survey Limitations under the next heading).

The survey methods were not complaint with current best practice Fauna Survey Guidelines for a full impact assessment, such as those endorsed by local councils in the Lower Hunter area (LHCCREMS 2002). The fauna habitat assessment undertaken is considered sufficient to flag any potential impacts on threatened fauna and general faunal diversity within the study area and will provide a good basis for comparing the relative potential impacts of each preferred route option. Additional fauna survey work would be required once a preferred option is chosen and may include the use of Elliott traps, hair tubes, harp traps, formal bird and reptile surveys, nocturnal call playback and ultrasonic call detection.

3.2.2 Survey Limitations

The fauna field survey was limited to a daytime field habitat assessment within the study area. In addition, the survey could only be conducted from within the railway easement itself and from within the highway easement for the deviation option (Option 1). No private property could be accessed in any part of the designated study area. Therefore, identification of fauna species and habitat features could only be undertaken remotely via ‘over the fence’ observations.

Only opportunistic observations of fauna and faunal activity were recorded during the habitat assessment. A full fauna survey would reveal a greater diversity of species and would include nocturnal fauna.

3.2.3 Fauna Survey Results

Opportunistic Observations

A total of 43 fauna species were recorded within the study area during the field habitat assessment, comprising 35 birds, five reptiles and three mammals. Of these, four are introduced species and the remainder native. All are generally common, widespread species and most are readily found in disturbed environments and agricultural areas.

The western section of the study area is comprised mostly of highly modified agricultural land, while the eastern section contains larger areas of remnant native vegetation. Most of the bird species identified within the study area are commonly found in agricultural areas, including the Australian magpie, Australian raven, brown falcon, galah and rufous songlark. Some of the observed bird species (eg. the galah, eastern rosella, pardalotes, thornbills and honeyeaters) rely upon isolated patches of vegetation or solitary trees for breeding, roosting and foraging purposes. Wet areas within the study area provide habitat for a number of bird species, including the clamorous reed-warbler, pacific black duck and white-faced heron. Built structures (eg. bridges, culverts) provide nesting habitat for the fairy martin.

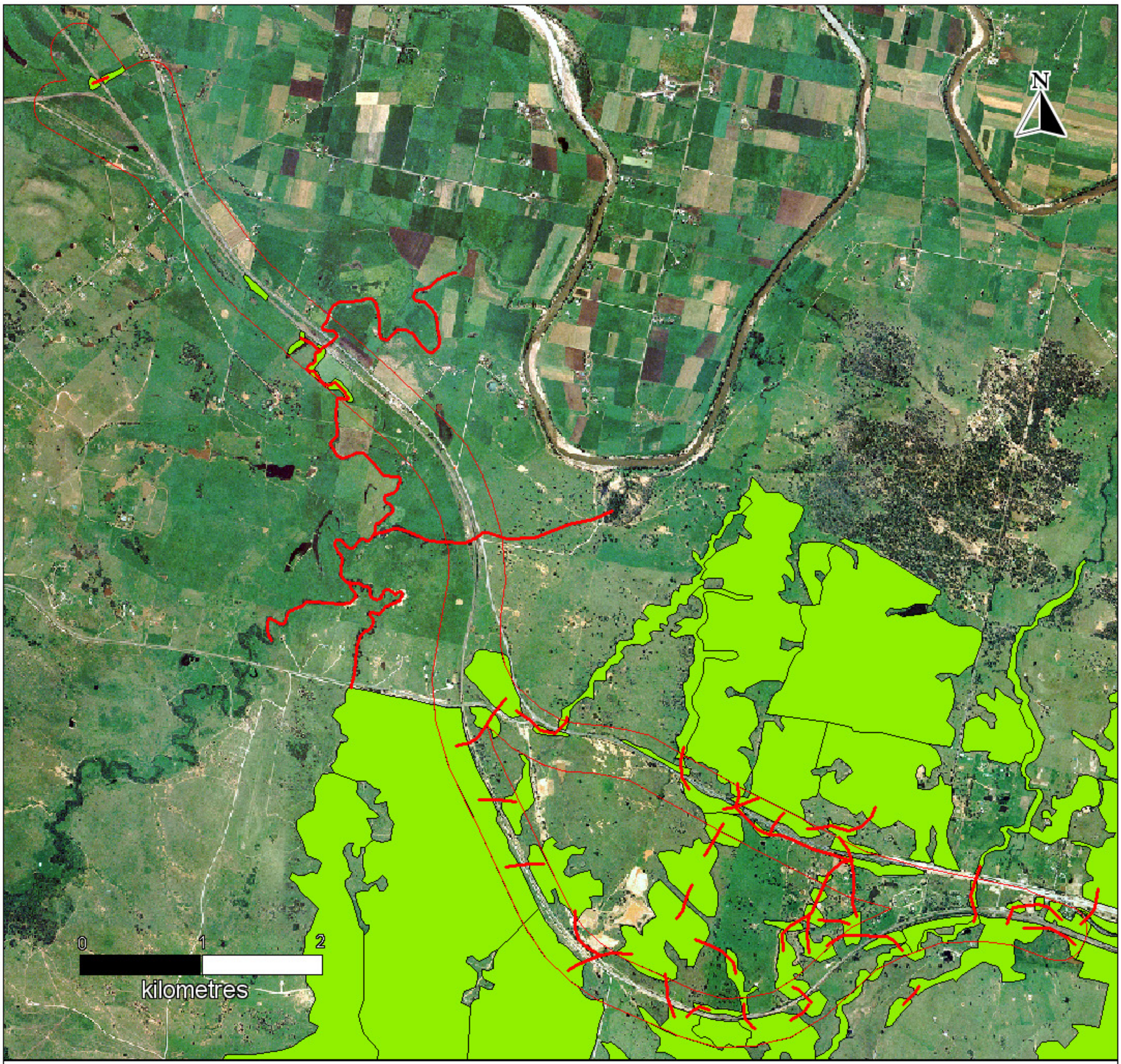
All five reptile species were recorded south and east of the Golden Highway, possibly reflecting the greater diversity of natural habitats in the eastern section of the study area. The bearded dragon, robust ctenotus and eastern blue-tongued lizard could be found anywhere in the study area, though are more likely to occur in areas where some remnant vegetation occurs. The eastern snake-necked turtle and eastern water dragon are likely to occur in creeklines and suitable wet areas throughout the study area.

Two mammal species, the eastern grey kangaroo and rabbit, were observed along both the highway and existing track alignment options. Common brushtail possum scratches were observed on the trunks of trees in a patch of planted yellow box in the western section of the study area near Racecourse Lane.

Given further survey work, it is expected that a greater number of fauna species would be recorded within the study area. This would include groups that require specific survey techniques for detection, including insectivorous bats, nocturnal birds and arboreal mammals. A list of all species recorded in the study area during this survey is presented in **Appendix 2**.

Corridor Links

The western section consists of predominantly cleared land, though vegetation along Mudies Creek may provide a movement corridor for more mobile species (particularly birds and bats). The main potential fauna movement corridors occur in the eastern section of the study area and are shown in **Figure 4**.



Key

- 🟥 Connectivity Link
- 🟩 Remnant Vegetation

Aerial Photo Source: NSW Department of Lands SIX Viewer www.maps.nsw.gov.au

Ecotone Ecological Consultants Pty Ltd

Figure 4. Fauna Movement Corridors

Flora and Fauna Constraints Assessment: Proposed Third Rail Track at Minimbah Bank near Belford

November 2007

Threatened Fauna Habitat

No threatened fauna species were recorded during the field habitat assessment. One potential grey-crowned babbler's nest was observed in the distance south of the Golden Highway on the western side of the existing rail easement however it was too far away to identify with certainty. Based on the habitat available within the study area, a number of threatened fauna species have potential to occur. For each vegetation community and specific habitat feature a list of potential threatened fauna species has been prepared as follows:

Community 1: Ironbark/spotted gum/grey box woodland/open forest

Most of the identified subject species have some potential to occur within this community, particularly in the larger tracts of remnant vegetation in the eastern section of the study area south of the existing rail track and north of the New England Highway.

Glossy black-cockatoo	-may occasionally visit as limited *Allocasuarina littoralis* occurs - no suitable nest hollows were observed, though survey was limited
Brown treecreeper	-potential foraging and some potential nest sites observed
Black-chinned honeyeater	-potential foraging and nesting (though more likely to be an occasional opportunistic visitor than to breed within the area)
Painted honeyeater	-potential foraging and nesting (though more likely to be an occasional opportunistic visitor than to breed within the area)
Turquoise parrot	-potential foraging, limited potential nesting
Diamond firetail	-potential foraging and nesting
Hooded robin	-potential foraging and nesting
Barking owl	-potential foraging
Powerful owl	-potential foraging - no suitable nest hollows were observed, though survey was limited
Masked owl	-potential foraging
Swift parrot	-occasional, opportunistic visitor (foraging only)
Regent honeyeater	-occasional opportunistic visitor (foraging only)
Square-tailed kite	-potential foraging; no good nesting trees observed (though survey was limited)
Grey-crowned babbler	-potential foraging and nesting
Speckled warbler	-potential foraging and nesting
Little bentwing-bat	-potential foraging
Eastern bentwing-bat	-potential foraging
East-coast freetail-bat	-potential foraging, roosting and breeding
Greater broad-nosed bat	-potential foraging, roosting and breeding
Yellow-bellied sheathtail-bat	-potential foraging, limited potential roosting and breeding
Grey-headed flying-fox	-potential foraging
Spotted-tailed quoll	-potential foraging and possible den hollows in larger areas of intact vegetation – may also forage within smaller nearby remnants, but is unlikely to visit isolated patches
Brush-tailed phascogale	-potential foraging and possible nest hollows in larger areas of intact vegetation – may also forage within smaller nearby remnants, but is unlikely to visit isolated patches
Squirrel glider	-potential foraging and possible nest hollows in larger areas of intact vegetation – may also forage within smaller nearby remnants, but is unlikely to visit isolated patches
Koala	-potential shelter and movement corridor only

Community 2: Forest red gum floodplain woodland/open forest

As for Community 1, with the addition that potential foraging habitat for the koala occurs within this community.

Community 3: Riparian forest/shrubland

As for Community 2, with the addition that potential foraging habitat is available for the southern myotis where open water occurs.

Communities 4 & 5: Plantations/vineyards and cleared pasture

Given the disturbance history within these areas, less potential threatened fauna habitat is available within these two communities. However a number of species still have potential to occur, particularly grassland specialists.

Barking owl	-potential foraging
Grass owl	-potential foraging and nesting in areas of tall grass; heavily grazed areas are unsuitable for this species
Masked owl	-potential foraging along vegetated edges
Turquoise parrot	-potential foraging, particularly near remnant woodland
Greater broad-nosed bat	-potential foraging along remnant woodland edges
Yellow-bellied sheathtail-bat	-potential foraging

Hollows

Hollows occurring in living trees, dead stags and fallen timber provide potential breeding and roosting habitat for a range of threatened species, including the glossy black-cockatoo, brown treecreeper, turquoise parrot, spotted-tailed quoll, brush-tailed phascogale, squirrel glider, owls and insectivorous bats.

Occasional large fallen logs were observed during the field habitat assessment and these may provide potential nesting habitat for the brown treecreeper and brush-tailed phascogale. While some of these fallen logs may contain large hollows, given the fragmented nature of habitat in the immediate vicinity of the existing rail track and highway, it is unlikely that these would be utilised by the spotted-tailed quoll.

The only tree hollows observed during the field habitat assessment were small hollows that may provide potential roost/nest sites for insectivorous bats and perhaps the brown treecreeper, turquoise parrot, brush-tailed phascogale and squirrel glider. No large hollows suitable for use by the glossy black-cockatoo or owls were observed, though given the limited nature of the survey it is quite possible that some large hollows may occur in trees outside of the existing rail track and highway easements.

Culverts/bridges

A number of bridges and culverts occur where the existing rail track and New England Highway cross watercourses within the study area. During the field habitat survey, some of these were observed to contain potential roost sites for the little bentwing-bat, eastern bentwing-bat and southern myotis. However these species are unlikely to breed within the study area as no suitable maternity roost sites were observed.

Watercourses, dams, etc.

Dams and other open water bodies within the study area provide potential foraging and breeding habitat for the green and golden bell frog, though there are no records within the locality and most known extant populations of this species tend to be located closer to the coast. The southern myotis has potential to forage over open water bodies within the study area and other insectivorous bats are likely to utilise flyways provided by vegetated watercourses within the study area.

4.0 ASSESSMENT OF THE PROPOSAL

4.1 Commonwealth and NSW State Legislative Requirements

4.1.1 Threatened Species Assessment (Section 5A of the EP&A Act 1979)

The *TSC Act* was gazetted in late 1995 and aims to conserve threatened species, populations and ecological communities of animals and plants. Specific objectives of the *Act* are to: -

a) conserve biological diversity and promote ecologically sustainable development;

b) prevent the extinction and promote the recovery of threatened species, populations and ecological communities that are endangered;

c) protect critical habitat of those threatened species, populations and ecological communities;

d) eliminate or manage certain processes that threaten the survival or evolutionary development of those threatened species, populations and ecological communities;

e) ensure that the impact of threatening actions are properly assessed; and

f) encourage the conservation of threatened species, populations and ecological communities by the adoption of measures involving co-operative management.

Section 5A ('eight part test') of the *EP&A Act 1979* was amended by the *TSC Act 1995*. This Section aims to improve the standard of consideration and protection afforded to threatened species, populations and communities, and their habitats in the planning process. The outcome of any threatened species assessment should be that developments and activities are undertaken in an environmentally sensitive manner, and that appropriate measures are undertaken to minimise adverse effects on threatened species or their habitats. Determining authorities have an obligation under the *EP&A Act* to consider whether a proposal is likely to significantly affect threatened species, populations or ecological communities, or their habitats. In this regard, the determining authority must take into account the 'eight part test.' Discussions of species investigated under the provisions of Section 5A have been detailed below:

4.1.1.1 Threatened Flora

No threatened flora species listed by the TSC Act were recorded within the study area, although there is a possibility that slaty red gum *Eucalyptus glaucina* could occur within the inaccessible areas of private property and was therefore not recorded. Since this species is considered by Peake (2006), to be sub-dominant in the Belford district through to the Singleton Military Area, a seven-part test of significance would need to be carried out on this species even if it were not recorded in the study area from a survey for the preferred route.

4.1.1.2 Endangered Populations

One species that forms an Endangered Population in the Hunter catchment, river red gum *Eucalyptus camaldulensis*, was tentatively recorded in three locations in adjoining private land near the easement boundary during the field survey (**Figure 3**), all to the south of the railway easement. Additional occurrences of the species may be present within private property further away from the easement boundary. A seven-part test of significance is likely to be required for this endangered population.

4.1.1.3 Endangered Ecological Communities

At least two endangered ecological communities and possibly three are considered to occur in the study area. The definite EECs are 'Hunter lowland redgum forest' and 'swamp oak floodplain forest', which are potentially affected by all three options. The broad extent to which the EECs are likely to be affected by each option is given in **Table 8**. In general, Option 1 would be likely to have the greatest impact on EECs, while Options 6 and 7 would both have a similar impact to one another with Option 7 possibly having a higher impact than Option 6.

The only other EEC that could occur in the study area is Lower Hunter Spotted Gum Ironbark Forest, although this EEC is not mapped by Peake (2006) as extending as far west as the study area. Nevertheless, small patches of Community 1 in private property could contain elements of this EEC. This would need to be confirmed by a full assessment of the vegetation within the relevant properties for the preferred route assessment.

A seven-part test of significance would need to be carried out in relation to all EECs confirmed to be present within the alignment for the preferred route.

4.1.1.4 Threatened Fauna

No threatened fauna species were recorded within the study area however survey work thus far has been limited to only a field habitat assessment. Based on the field habitat assessment and literature review, those threatened species considered most likely to occur are the grey-crowned babbler, speckled warbler, eastern bentwing-bat, grey-headed flying-fox and squirrel glider. A number of additional threatened species have potential to occur and a seven-part test would need to be carried out on all of the identified subject species (listed in **Section 2.3.3**).

The broad extent to which threatened fauna is likely to be affected by each option is given in **Table 8**. In general, Option 6 is considered likely to result in the least impact on threatened fauna habitat within the study area. This is based on the relative amount of vegetation clearing likely to be required for each option and the presence of particular fauna habitat attributes (for example hollow-bearing trees). The main potential impacts likely to result from the proposal are:

- The further fragmentation of habitat and widening of existing gaps between patches of remnant vegetation.
- The loss of roost and nest sites if habitat trees are removed.
- The loss of roost sites if bridges and culverts are removed or altered.
- The increased likelihood of death or injury from being hit by a train due to increased rail traffic.
- The loss of a small extent of foraging habitat.

4.1.1.5 Key Threatening Processes

To date, 32 key threatening processes have been finally determined under the provisions of the TSC Act. Those that may be potentially relevant to the proposal are listed below:

- Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands
- Clearing of native vegetation
- Human-caused climate change
- Infection of frogs by the amphibian chytrid causing the disease chytridiomycosis

- Infection of native plants by *Pytophthora cinnamomi*
- Invasion of native plant communities by exotic perennial grasses
- *Lantana camara*
- Loss of hollow-bearing trees
- Predation by the plague minnow (*Gambusia holbrooki*)
- Removal of dead wood and trees

4.1.2 Environment Protection & Biodiversity Conservation Act 1999 (EPBC Act)

The EPBC Act was gazetted on the 16th July 2000 replacing several earlier Commonwealth statutes. This Act focuses Commonwealth interests on matters of national environmental significance including integrated biodiversity conservation and the management of important protected areas. The Act also establishes a streamlined environmental assessment and approvals process.

The matters of national environmental significance as identified in the Act which require assessment and approval to be addressed by the Commonwealth include:

- World Heritage properties
- National Heritage places
- Ramsar wetlands
- Nationally threatened species and ecological communities (Part 13, Division 1, Subdivision A of the EPBC Act)
- Migratory species
- Commonwealth Marine areas
- Nuclear actions (including uranium mining)

The assessment and approval process focuses on any action that has, will have or is likely to have a significant impact on a matter of national environmental significance. An ‘action’ is defined as a project, development, undertaking or an activity or series of activities.

The relevant criteria given in the administrative guidelines for the Act to determine whether the action will or is likely to have a significant impact are as follows:

Critically endangered and endangered species

Criteria

An action has, will have, or is likely to have a significant impact on a critically endangered or endangered species if it does, will, or is likely to:

- lead to a long-term decrease in the size of a population, or
- reduce the area of occupancy of the species, or
- fragment an existing population into two or more populations, or
- adversely affect habitat critical to the survival of a species, or
- disrupt the breeding cycle of a population, or
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*, or
- interfere with the recovery of the species.

* Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a critically endangered or endangered species by direct competition, modification of habitat, or predation.

Vulnerable species

Criteria

An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to:

- lead to a long-term decrease in the size of an important population of a species, or
- reduce the area of occupancy of an important population, or
- fragment an existing important population into two or more populations, or

- adversely affect habitat critical to the survival of a species, or
- disrupt the breeding cycle of an important population, or
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
- result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat*, or
- interferes substantially with the recovery of the species.

An important population is one that is necessary for a species' long-term survival and recovery. This may include populations that are:

- key source populations either for breeding or dispersal,
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.
- Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a vulnerable species by direct competition, modification of habitat, or predation.

Listed migratory species (non threatened species only)

Criteria

An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species, or
- result in invasive species that is harmful to the migratory species becoming established* in an area of important habitat of the migratory species, or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

An area of important habitat is:

1. habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, or
2. habitat utilised by a migratory species which is at the limit of the species range, or
3. habitat within an area where the species is declining.

Threatened Flora or Ecological Communities

No flora species or Threatened Ecological Communities listed by the Act were recorded within the study area, although slaty red gum *Eucalyptus glaucina* which is listed as vulnerable under the Act could occur in some areas of private property that could not be accessed. It is unlikely that any of the options would affect the species to the extent that a significant impact would result.

Threatened and Migratory Fauna

No fauna species listed by the TSC Act were recorded within the study area during the field habitat assessment. However a number of species are predicted to occur or have habitat available within the study locality according to EPBC modelling (refer to **Table 4**).

Of the thirteen threatened species listed in the EPBC Act protected matters report (**Table 4**), five are considered to have some potential to occur based on habitat available within the study area. These are the green and golden bell frog, spotted-tailed quoll, swift parrot, regent honeyeater and grey-headed flying-fox. Of these, the swift parrot, regent honeyeater and grey-headed flying-fox would only visit the area on a seasonal or opportunistic basis, particularly when winter-flowering eucalypts, such as the spotted gum, are in bloom. Potential foraging and breeding habitat for the green and golden bell frog occurs in dams and other open water bodies within the study area, however there are no records from within the locality and most known extant populations of this species tend to be located closer to the coast. The spotted-tailed quoll may forage within the study area, though given the fragmented nature of the available habitat it is unlikely to den in the area.

Of the eleven migratory species listed in the EPBC Act protected matters report (**Table 4**), six are considered to have some potential to occur based on habitat available within the study area. These are the regent honeyeater, cattle egret, great egret, latham's snipe, rainbow bee-eater and white-throated needletail. None of these species are expected to breed within the study area and all except the cattle egret are likely to only be occasional visitors.

It is considered unlikely that any of the proposed alignment options would result in a significant impact upon a local population of any threatened or migratory species listed in the EPBC Act.

Key Threatening Processes

Seventeen key threatening processes have been finally determined under the EPBC Act. Four of these could be potentially relevant to the proposal and are discussed below:

1) Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*); and
2) Infection of amphibians with chytrid fungus resulting in chytridiomycosis

With regard to items 1) and 2), the main issue is the risk of importing *Phytophthora cinnamomi* or chytrid fungus into or out of the study area. This risk can be managed by ensuring that no soil or water is transferred into or out of the study area. This would involve all tools, vehicles and machinery being cleaned, disinfected and dried before coming onto or leaving the subject site.

3) Land clearance

All of the proposed alignment options involve some land clearance, though Option 6 is likely to require less clearing of native vegetation than the other two options.

4) Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases

As a result of the use of vehicles and other machinery, all options are expected to result in the emission of a small amount of greenhouse gases.

No other Matters of National Environmental Significance appear to be relevant in relation to the proposed alignment options.

4.1.3 Native Vegetation Act 2003

The *Native Vegetation Act 2003* (NV Act) applies to the clearing of native vegetation from all land in NSW except within conservation reserves, state forests and urban areas. Urban areas include any areas zoned residential (but not rural residential), village, township, industrial or business. The proposal is likely to be subject to the provisions of the NV Act. The Hunter-Central Rivers Catchment Management Authority (CMA) should be contacted for a definitive ruling on obligations of the proponent under the Act, once a final proposal for the third rail track alignment is adopted.

4.1.4 Rivers and Foreshores Improvement Act 1948

It is intended that this act will eventually be included under the *Water Management Act 2000*; however, it is still in force at this point in time. The *Water Management Act* covers all waters, including coastal waters to the three mile nautical limit.

With regards to this proposal the *Rivers and Foreshores Improvement Act 1948* is relevant in that development is proposed within 40m of a recognised watercourse. Once a final alignment option is chosen, it is likely that the NSW Department of Water and Energy would need to be contacted to undertake an assessment of riparian issues and conservation requirements.

4.1.5 Fisheries Management Act, 1994

Under the *Fisheries Management Act, 1994*, Part 7 (3, 4, 5 & 8), NSW Fisheries must be informed of any 'construction of bridges, roads, causeways, culverts, pipelines, cables or similar structure that impinge upon or are adjacent to (within 50 m) aquatic habitats' (NSW Fisheries, 1999). All three proposed alignment options cross a number of watercourses that provide potential fish habitat within the study area and therefore the proposal would require assessment according to the NSW Fisheries Policy.

Two of the seven threatening processes listed under Schedule 6 of the Act are considered potentially relevant to the proposal:

- Degradation of riparian vegetation along New South Wales water courses
- Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams

Other potential impacts arising from the construction and modification of bridges, roads, causeways, culverts, pipelines, cables and other similar structures that have been identified as a threat to fish habitats (NSW Fisheries, 1999) include:

- barriers to fish passage
- water pollution - sedimentation, turbidity, nutrients, acid sulphate soils, oils and heavy metals
- loss or changes to fish habitat
- impacts on threatened species

4.1.6 State Environmental Planning Policy No. 44 - Koala Habitat Protection (SEPP44)

SEPP 44 was implemented on the 13th of February, 1995, with the reasoning that the current known distribution of the koala in NSW is fragmented, with most colonies appearing to be small and isolated. Many of these populations are in locations that are under increased pressure from habitat loss or modification, predation and exposure to drought, disease and bushfire. These facts are the reason for the koala being listed as 'Vulnerable' in Schedule 2 of the Threatened Species Conservation Act, 1995.

Prior to a development application for bushland areas being approved, the following considerations need to be assessed:

a) identification of "potential koala habitats" within the proposed development area; if the total tree cover contains 15% or more of the koala food tree species listed in Schedule 2 of SEPP 44 then it is deemed to be "potential koala habitat";
b) identification of "core koala habitat" within the development area. "Core koala habitat" is defined as an area of land with a resident population of koalas, evidenced by attributes such as breeding females (females with young), recent sightings and historical records of a koala population;

c) identification of "core koala habitat" will require that a plan of management must accompany the DA application;
d) if the rezoning of lands, other than to environmental protection, involves potential or core koala habitat then the Director of planning may require a local environmental study be carried out.

As Singleton LGA is listed in Schedule 1 of SEPP44, the proposal would need to include an assessment of potential impacts on koala habitat according to the criteria specified in SEPP 44.

One preferred food species listed in SEPP 44 (Forest Red Gum *Eucalyptus tereticornis*) was positively identified within the study area during the field habitat assessment. One additional species that forms an Endangered Population in the Hunter catchment (River Red Gum *Eucalyptus camaldulensis*) was tentatively recorded in three locations in adjoining private land south of the existing railway easement.

An inspection of leaf litter at the base of accessible forest red gums within the existing rail and road easements was made during the field habitat assessment though no koala scats or other evidence of koala activity was observed. Given the limitations of the field habitat assessment, further survey work would be necessary in order to meet the requirements of SEPP44.

4.2 Regional or Singleton Council Planning Requirements

4.2.1 Singleton Council Local Environmental Plan 1996

The proposal would need to comply with the requirements of the Singleton LEP. As all of the three proposed options are likely to pass through various parcels of land with different zonings, Singleton Council should be contacted for a definitive ruling on obligations of the proponent once a final proposal for the third rail track alignment is adopted.

4.3 Comparison of Alignment Options

Three preferred alignment options for the proposed rail track were investigated during the field habitat assessment an additional survey coverage area at the northern end was inspected from within the rail easement area. While access was limited, from aerial photographs the area appears to be mostly cleared although a small patch of riparian forest/shrubland was observed and at least one dam is present. **Table 8** contains a summary of the potential ecological impacts associated with each of the three alignment options.

Option One

From Belford, Option 1 runs parallel to the New England Highway to rejoin the existing rail track alignment just north of the Golden Highway. Based on the field survey work, this option is considered likely to have a relatively high ecological impact compared to Options 6 and 7. This conclusion is based primarily on the greater extent of native vegetation likely to require removal and the potential for increased fragmentation of bushland north of the New England Highway.

Option Six

Option 6 runs parallel to and on the northern side of the existing rail track. This option is considered to have the relatively lowest ecological impact compared to Options 1 and 7. This conclusion is based primarily on the lesser extent of native vegetation likely to require removal. In addition, while Option 6 is likely to result in the widening of the current gap between patches of vegetation across the rail easement, no additional bushland areas are likely to become fragmented or isolated as a result of this option.

Option Seven

Option 7 runs parallel to and on the southern side of the existing rail track. This option is considered to have a relatively low to moderate ecological impact compared to Options 1 and 6. This option is likely to require the removal of more vegetation than Option 6, as widening the existing rail easement may result in the loss of a long strip of vegetation south of the Golden Highway. However, unlike Option 1, Option 7 is unlikely to result in additional bushland areas becoming fragmented or isolated.

Table 8. Comparison of Alignment Options

Alignment Option	Vegetation	Endangered Ecological Communities	Threatened Flora/Endangered Population Habitat	Threatened Fauna Habitat	Watercourses	Corridor Links	Overall Assessment
1	Large areas of natural vegetation to be cleared including fragmentation of patches	1. Hunter Lowland Redgum Forest – possible minor impacts 2. Swamp Oak Floodplain Forest – moderate impact 3. River-flat Eucalypt Forest – minor impact	1. Possible *Eucalyptus glaucina* habitat 2. Possible *Eucalyptus camaldulensis* habitat	All subject species – possible loss of roost/nest hollows, some clearing of potential foraging habitat. Increased fragmentation for some species (eg. squirrel glider).	Crosses Mudies Creek, Jump Up Creek and an unnamed watercourse	Widening of gaps between patches of remnant vegetation (see **Figure 4**) and potential further fragmentation.	Relatively high impact
6	Possible small strips of natural vegetation to be cleared at edges of patches only - limited fragmentation of habitat	1. Hunter Lowland Redgum Forest – possible minor impacts 2. Swamp Oak Floodplain Forest – negligible impact 3. River-flat Eucalypt Forest – minor impact	1. Possible *Eucalyptus glaucina* habitat 2. Possible *Eucalyptus camaldulensis* habitat	All subject species – loss of roost/nest hollows unlikely, limited clearing of potential foraging habitat. Slightly increased fragmentation for some species (eg. squirrel glider).	Crosses Mudies Creek, Jump Up Creek and parallel to an unnamed watercourse for a short section	Widening of gaps between patches of remnant vegetation (see **Figure 4**).	Relatively low impact (best option)
7	One possible long strip and several shorter strips of natural vegetation to be cleared at edges of patches only - limited fragmentation of habitat	1. Hunter Lowland Redgum Forest – possible minor impacts 2. Swamp Oak Floodplain Forest – negligible impact 3. River-flat Eucalypt Forest – minor impact	1. Possible *Eucalyptus glaucina* habitat 2. *Eucalyptus camaldulensis* habitat	All subject species – possible loss of roost/nest hollows, some clearing of potential foraging habitat. Slightly increased fragmentation for some species (eg. squirrel glider).	Crosses Mudies Creek, Jump Up Creek and parallel and close to the bank of Jump Up Creek for some distance	Widening of gaps between patches of remnant vegetation (see **Figure 4**).	Relatively low to moderate impact

5.0 CONCLUSION

An assessment and comparison of the potential constraints resulting from flora and fauna issues for three alignment options and an additional area at the Mt Thorley interchange for the proposed Minmbah Bank third rail track has been made based on a combination of literature review and field survey. The resulting information has been used to anticipate the likely requirements of Section 5A of the *Environmental Planning and Assessment Act 1979* and other relevant legislation for the proposed new rail track at Minimbah Bank.

No threatened flora species listed under legislation were recorded within the study area, although it is possible that the slaty red gum *Eucalyptus glaucina* could occur in private property outside the existing rail track and highway easements. One species that forms an Endangered Population in the Hunter catchment, the river red gum *Eucalyptus camaldulensis*, was tentatively recorded in three locations south of the existing railway easement. Given the limitations of the field survey, it is uncertain whether either *Eucalyptus glaucina* or *Eucalyptus camaludulensis* occur within the study area. It is therefore difficult to assess the relative potential impact of each of the three alignment options and it must be assumed that habitat for both species has potential to be impacted by any of the three alignment options.

Two endangered ecological communities listed under the TSC Act are considered to occur within the study area. These are *Hunter lowland redgum forest* and *swamp-oak floodplain forest*. In addition, it is possible that minor elements of a third EEC, *Lower Hunter spotted gum-ironbark forest*, occur within the study area. In general, Option 1 would be likely to have the greatest impact on EECs, while Options 6 and 7 would both have a similar impact to one another, with Option 7 possibly having a slightly higher impact than Option 6.

No threatened fauna species were recorded within the study area however survey work thus far has been limited to only a field habitat assessment. Based on the field habitat assessment and literature review, those threatened species considered most likely to occur are the grey-crowned babbler, speckled warbler, eastern bentwing-bat, grey-headed flying-fox and squirrel glider. A number of additional threatened species have potential to occur and these would all need to be assessed under the relevant legislation. The main potential impacts on threatened fauna are considered to be the further fragmentation of habitat, the loss of roosting/nesting habitat, the increased likelihood of death or injury from increased rail traffic and the loss of a small extent of foraging habitat. In general, Option 6 is considered likely to result in the least impact on threatened fauna habitat within the study area. This conclusion is based on the relative amount of vegetation clearing likely to be required for each option and the presence of particular fauna habitat attributes (for example hollow-bearing trees).

Given that survey work so far has been limited to within the existing rail track and highway easements, the occurrence and locations of threatened flora and fauna species, populations and endangered ecological communities would need to be clarified during more detailed field surveys, including those parts of the study area in private property.

6.0 RECOMMENDATIONS

All three options are likely to involve some clearing of native vegetation and disturbance to flora and fauna habitat within the study area. The following recommendations would apply to the preferred option, regardless of which alignment option is decided upon:

- Further flora survey work is required in those areas unable to be accessed during the initial survey (ie. on private land outside the existing rail track and highway easements).

- A detailed fauna survey within the study area is required. This is likely to include nocturnal survey techniques (spotlighting, call playback, ultrasonic bat call detection and possibly harp trapping) as well as diurnal survey techniques (in particular bird and reptile surveys, koala scat searches and mapping of habitat trees).

- It is recommended that as much native vegetation be retained as possible, in order to minimise the assessment requirements under the Native Vegetation Act 2003. In particular, the selection of the precise alignment of the preferred route should take care to avoid the need for clearing of vegetation in areas identified as an endangered ecological community.

- It is recommended that the removal of habitat trees be avoided wherever possible, as these provide important nesting and roosting habitat for fauna, including threatened species.

- It is recommended that existing fauna movement corridor links be retained and that gaps between patches of vegetation are not extended to greater than 30-40m in width. This will assist in maintaining a continuous link for squirrel gliders, as this species is known to be able to negotiate a glide distance of 30-40m (depending on the height of the launch tree).

- Underpasses and overpasses could also assist in maintaining habitat connectivity for fauna. A number of potential underpasses already exist at culvert and bridge crossings within the study area and the further use of such structures (perhaps with greater emphasis on appropriate design for fauna movement) in the proposed third track project is recommended.

7.0 REFERENCES

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8.0 APPENDICES

Appendix 1. Flora Species Recorded in the Study Area

The following is a list of all flora species recorded within the study area. Please note that this list may be not fully comprehensive, and should be regarded as an indication of the flora present. The list primarily documents the flora present within the railway and highway easements. Additionally, a period of some years is often needed to identify all species present in an area, particularly for cryptic or seasonally detectable species (such as orchids and small grass-like herbs).

Notes:

* indicates an exotic or introduced native species
R indicates locally indigenous species that are potentially suitable for revegetation or replanting works

Nomenclature follows Harden (1990, 1992, 1993, 2002), Harden & Murray (2000) and subsequent recent revisions from PlantNET http://plantnet.rbgsyd.nsw.gov.au/

E = Existing Railway options
H = Highway Deviation option

CLASS / FAMILY / *Scientific Name*		**Common Name**	**Recorded**	
			E	**H**
CLASS FILICOPSIDA (Ferns)				
ADIANTACEAE				
Cheilanthes sieberi subsp. *sieberi*	R	Mulga fern	E	
AZOLLACEAE				
Azolla filiculoides var. *rubra*	R	Pacific azolla	E	
MARSILEACEAE				
Marsilea hirsuta	R	A nardoo	E	
CLASS CONIFEROPSIDA (Conifers)				
CUPRESSACEAE				
Callitris endlicheri	R	Black cypress pine		H
CLASS MAGNOLIOPSIDA (Flowering Plants)				
Subclass Magnoliidae (Dicotyledons)				
AIZOACEAE				
Carpobrotus glaucescens	R	Pigface	E	
*Galenia pubescens**		Galenia	E	
ANACARDIACEAE				
*Schinus ariera**		Pepper tree	E	
APIACEAE				
*Foeniculum vulgare**		Fennel	E	H
APOCYNACEAE				
*Nerium oleander**		Oleander	E	H
ASCLEPIADACEAE				
*Gomphocarpus fruticosus**		Narrow leaf cotton bush	E	H
Marsdenia rostrata	R	Common milk vine	E	

CLASS / FAMILY / *Scientific Name*		**Common Name**	**Recorded**	
			E	**H**
ASTERACEAE				
*Ambrosia artemisiifolia**		Annual ragweed	E	
*Bidens pilosa**		Cobblers pegs	E	
Cassinia aculeata	R	Dogwood/dolly bush		H
*Chondrilla juncea **		Skeleton weed	E	
Chrysocephalum apiculatum	R	Yellow buttons	E	H
*Cirsium vulgare**		Spear thistle / black thistle	E	H
Conyza sp.*		Fleabane	E	
*Lactuca serriola**		Compass plant/prickly lettuce	E	H
Ozothamnus diosmifolius	R	Ball everlasting/pill flower/ rice flower	E	H
*Senecio madagascariensis**		Fire weed		H
*Silybum marianum**		Variegated thistle	E	
*Sonchus oleraceus**		Common sowthistle	E	H
*Tragopogon porrifolius**		Salsify/oyster plant		H
Vernonia cinerea		-		H
*Xanthium spinosum**		Bathurst burr	E	
BASELLACEAE				
*Anredera cordifolia**		Madeira vine		H
BIGNONIACEAE				
*Jacaranda mimosifolia**		Jacaranda	E	
BORAGINACEAE				
*Echium plantagineum**		Paterson's curse	E	
BRASSICACEAE				
*Hirschfeldia incana**		Hairy brassica/buchan weed	E	
*Lepidium africanum**		Common peppercress		H
CACTACEAE				
Opuntia stricta var. *stricta**		Common prickly pear/smooth pest pear		H
CAMPANULACEAE				
Wahlenbergia communis	R	Tufted bluebell	E	H
CAPRIFOLIACEAE				
*Lonicera japonica**		Honeysuckle	E	
CASUARINACEAE				
Allocasuarina littoralis	R	Black she-oak	E	
Casuarina glauca	R	Swamp she-oak	E	H
CHENOPODIACEAE				
Enchylaena tomentosa		Ruby saltbush	E	
CONVOLVULACEAE				
Dichondra repens	R	Kidney weed		H
Polymeria calycina		Swamp bindweed	E	
CRASSULACEAE				
*Bryophyllum delagoense**		Mother of millions		H
Crassula sieberiana subsp. *sieberiana*		Austral stonecrop	E	
EUPHORBIACEAE				
*Chamaesyce dallachyana**		Caustic weed		H
*Ricinus communis**		Castor oil plant	E	

CLASS / FAMILY / *Scientific Name*		**Common Name**	**Recorded**	
			E	**H**
FABACEAE - Subfamily Faboideae				
Glycine tabacina sens. lat.	R	A love creeper		H
Hardenbergia violacea	R	False sarsaparilla	E	H
Jacksonia scoparia	R	Dogwood	E	
*Melilotus officinalis**		Common melilot	E	H
Pultenaea spinosa	R	A bush pea		H
*Robinia pseudoacacia**	R	Black locust / false acacia	E	
*Trifolium arvense**		Haresfoot clover	E	H
*Trifolium repens**		White clover	E	
Vicia sativa subsp. *nigra**		Narrow-leaved vetch	E	
FABACEAE - Subfamily Mimosoideae				
Acacia falcata	R	Falcate wattle		H
Acacia irrorata subsp. *irrorata*	R	Green wattle	E	H
*Acacia podalyriifolia** (Native of Queensland)		Queensland silver wattle		H
Vachellia farnesiana		Mimosa bush / thorny acacia	E	
FUMARIACEAE				
Fumaria muralis subsp. *muralis**		Wall fumitory	E	
GERANIACEAE				
Geranium homeanum		Northern cranesbill	E	
Geranium solanderi var. *solanderi*		Cutleaf cranesbill	E	
LAMIACEAE				
*Stachys arvensis**		Stagger weed	E	
LAURACEAE				
Endiandra sieberi ?	R	Hard corkwood	E	
LOBELIACEAE				
Pratia concolor		Poison pratia	E	
LORANTHACEAE				
Muellerina eucalyptoides		A mistletoe	E	H
MALACEAE				
*Cotoneaster glaucophyllus**		Cotoneaster		H
MALVACEAE				
*Modiola caroliniana**		Redflower mallow	E	H
*Pavonia hastata**		Pink pavonia		H
*Sida rhombifolia**		Paddy's lucerne	E	H
MELIACEAE				
Melia azedarach	R	White cedar		H
MYOPORACEAE				
Eremophila debilis	R	Amulla/winter apple		H
MYRTACEAE				
Angophora floribunda	R	Rough-barked apple	E	
Corymbia maculata	R	Spotted gum	E	H
***Eucalyptus camaldulensis?* End. Pop. in Hunter Reg.**	**R**	**River red gum**	**E**	
Eucalyptus crebra	R	Narrow-leaved ironbark	E	H
Eucalyptus fibrosa	R	Broad-leaved red ironbark	E	
Eucalyptus melliodora (planted)		Yellow box	E	
Eucalyptus moluccana	R	Grey box	E	H

CLASS / FAMILY / *Scientific Name*		**Common Name**	**Recorded** **E**	 **H**
MYRTACEAE (*cont.*)				
Eucalyptus paniculata subsp. *paniculata*	R	Grey ironbark	E	
Eucalyptus sideroxylon	R	Red ironbark/mugga		H
Eucalyptus tereticornis	R	Forest red gum	E	H
Melaleuca armillaris subsp. *armillaris*	R	Giant honeymyrtle	E	
Melaleuca linariifolia	R	Snow-in-summer	E	
OLEACEAE				
*Ligustrum lucidum**		Large-leaved privet	E	
Olea europaea subsp. *europaea**		Common olive	E	H
OXALIDACEAE				
Oxalis perennans		A wood sorrell		H
PLANTAGINACEAE				
*Plantago lanceolata**		Common plantain	E	H
POLYGONACEAE				
Persicaria hydropiper	R	Knotweed	E	
*Polygonum arenastrum**		Wire weed	E	
*Rumex crispus**		Curly dock	E	
PRIMULACEAE				
*Anagallis arvensis**		Pimpernel	E	H
PROTEACEAE				
Grevillea robusta	R	Silky oak	E	H
Hakea sericea	R	Bushy needlebush		H
RANUNCULACEAE				
Clematis aristata	R	Old man's beard / traveller's joy	E	
*Ranunculus repens**		Creeping buttercup	E	
*Ranunculus sceleratus**		Celery buttercup	E	
ROSACEAE				
*Rosa rubiginosa**		Sweet briar	E	
Rubus fruticosus species aggregate*		Blackberry	E	
RUBIACEAE				
Asperula conferta		Common woodruff	E	
*Galium aparine**		Goosegrass/cleavers	E	
SALICACEAE				
*Populus deltoides**		Cottonwood		H
*Salix babylonica**		Weeping willow	E	
SANTALACEAE				
Exocarpus cupressiformis	R	Cherry ballart	E	
SCROPHULARIACEAE				
*Verbascum virgatum**		Twiggy mullein	E	
SOLANACEAE				
*Solanum nigrum**		Blackberry nightshade	E	
ULMACEAE				
*Celtis occidentalis**		Hackberry	E	

CLASS / FAMILY / *Scientific Name*		**Common Name**	**Recorded** **E**	 **H**
VERBENACEAE				
*Verbena bonariensis**		Purpletop	E	
Verbena rigida var. *rigida**		Veined verbena	E	H
Subclass Liliidae (Monocotyledons)				
AGAVACEAE				
*Agave americana**		Century plant		H
ALLIACEAE				
*Nothoscordum borbonicum**		Onion weed	E	
ANTHERICACEAE				
Tricoryne elatior	R	Yellow rush-lily	E	
ARECACEAE				
*Phoenix canariensis**		Palm	E	
COMMELINACEAE				
Commelina cyanea		Scurvy weed	E	
*Tradescantia fluminensis**		Trad/wandering jew	E	H
CYPERACEAE				
Bolboschoenus caldwellii	R	-	E	
Eleocharis cylindrostachys	R	A spike-rush	E	
JUNCACEAE				
Juncus usitatus	R	Common rush	E	
JUNCAGINACEAE				
Triglochin procerum sens. lat.	R	Water ribbons	E	
LEMNACEAE				
Spirodela punctata		Duck weed	E	
LOMANDRACEAE				
Lomandra filiformis subsp. *filiformis*	R	Iron grass		
Lomandra multiflora subsp. *multiflora*	R	Many-flowered mat-rush		H
PHORMIACEAE				
Dianella caerulea var. *caerulea*	R	Blue flax lily		H
POACEAE				
Austrodanthonia sp.	R	Wallaby grass	E	H
Austrostipa pubescens	R	A speargrass	E	H
*Avena fatua**		Wild oats	E	H
Bothriochloa macra		Red-leg grass		H
*Briza maxima**		Quaking grass	E	H
*Briza minor**		Shivery grass	E	
*Bromus cartharticus**		Prairie grass	E	H
*Chloris gayana**		Rhodes grass	E	H
Cynodon dactylon		Couch	E	H
Dichelachne micrantha	R	Shorthair plumegrass	E	
*Eragrostis curvula**		African love grass	E	
*Eragrostis tenuifolia**		Elastic grass		H
*Hyparrhenia hirta**		Coolatai grass	E	H
Lachnagrostis filiformis	R	Blown grass	E	H
*Lolium perenne**		Perennial rye grass	E	

CLASS / FAMILY / ***Scientific Name***		**Common Name**	**Recorded**	
			E	**H**
POACEAE (*cont.*)				
*Melinis repens**		Red natal grass	E	H
*Paspalum dilatatum**		Paspalum	E	
*Paspalum urvillei**		Tall paspalum / vasey grass	E	
*Pennisetum clandestinum**		Kikuyu	E	H
Phragmites australis	R	Native reed/thatch reed	E	H
Poa labillardierei var. *labillardierei*		Tussock grass		
Themeda australis	R	Kangaroo grass	E	
*Triticum aestivum**		Common wheat/bread wheat	E	
*Zea mays**		Corn/sweet corn/maize	E	
TYPHACEAE				
Typha orientalis	R	Bullrush/cumbungi	E	H

Appendix 2. Fauna recorded within the Study Area

Notes:

AMG references for site
Map Grid 56
Southeast end of subject site: Easting 338800 Northing 6385200 Accuracy 100m
Northwest end of subject site: Easting 329800 Northing 6392100 Accuracy 100m

* indicates introduced species (not native to the area)
Bold indicates a threatened species
V - Vulnerable, E – Endangered, M- Migratory

Observation types:

O	observed	W	Heard	H	Hair, feathers or skin
F	tracks/scratchings	P	scat	E	Nest/roost
T	Trapped or netted	Y	Bone or teeth	Z	In raptor/owl pellet
K	Dead	X	In scat	R	Road kill
M	Miscellaneous	U	Ultrasonic call	d	Definite identification
p	Probable identification				

Mammals

Family / Scientific Name	Common Name	TSC Act	EPBC Act	Number of individuals	Observation type	NPWS code
Family: *PHALANGERIDAE*						
Trichosurus vulpecula	Common brushtail possum			1	F	1113
Family: *MACROPODIDAE*						
Macropus giganteus	Eastern grey kangaroo			2	O	1265
Family: *LEPORIDAE*						
Oryctolagus cuniculus *	Rabbit			1	O/E/F	1510

Reptiles

Family / Scientific Name	Common Name	TSC Act	EPBC Act	Number of individuals	Observation type	NPWS code
Family: *CHELIDAE*						
Chelodina longicollis	Eastern snake-necked turtle			1	O	2017
Family: *AGAMIDAE*						
Physignathus lesueurii	Eastern water dragon			1	O	2252
Pogona barbata	Bearded dragon			1	O	2177
Family: *SCINCIDAE*						
Ctenotus robustus	Robust ctenotus			1	O	2375
Tiliqua scincoides	Eastern blue-tongued lizard			1	O	2580

Birds

Family / Scientific Name	Common Name	TSC Act	EPBC Act	Number of individuals	Observation type	NPWS code
Family: *ANATIDAE*						
Anas superciliosa	Pacific black duck			1	O	0208
Family: *ARDEIDAE*						
Egretta novaehollandiae	White-faced heron			2	O	0188
Family: *THRESKIORNITHIDAE*						
Threskiornis spinicollis	Straw-necked ibis			1	O	0180
Family: *ACCIPITRIDAE*						
Aquila audax	Wedge-tailed eagle			1	O	0224
Family: *FALCONIDAE*						
Falco berigora	Brown falcon			1	O	0239
Family: *CHARADRIIDAE*						
Vanellus miles	Masked lapwing			1	O	0133
Family: *CACATUIDAE*						
Eolophus roseicapillus	Galah			1	O	0273
Family: *PSITTACIDAE*						
Platycercus eximius	Eastern rosella			1	O	0288
Family: *CUCULIDAE*						
Cuculus pallidus	Pallid cuckoo			1	O	0337
Family: *ALCEDINIDAE*						
Todiramphus sanctus	Sacred kingfisher			1	W	0326
Family: *CORACIIDAE*						
Eurystomus orientalis	Dollarbird			1	O	0318
Family: *MALURIDAE*						
Malurus cyaneus	Superb fairy-wren			1+	O	0529
Malurus lamberti	Variegated fairy-wren			1+	O	0536
Family: *PARDALOTIDAE*						
Pardalotus punctatus	Spotted pardalote			1	W	0565
Pardalotus striatus	Striated pardalote			2	W	0976
Acanthiza nana	Yellow thornbill			1	O	0471
Family: *MELIPHAGIDAE*						
Philemon corniculatus	Noisy friarbird			1	O	0645
Manorina melanocephala	Noisy miner			2+	O	0634
Lichenostomus penicillatus	White-plumed honeyeater			1	W	0625
Family: *PACHYCEPHALIDAE*						
Pachycephala rufiventris	Rufous whistler			1	W	0401
Family: *DICRURIDAE*						
Grallina cyanoleuca	Magpie-lark			2	O	0415
Rhipidura leucophrys	Willie wagtail			1	O	0364

Family: *CAMPEPHAGIDAE*						
Coracina novaehollandiae	Black-faced cuckoo-shrike			1	O	0424
Family: *ORIOLIDAE*						
Oriolus sagittatus	Olive-backed oriole			1	W	0671
Family: *ARTAMIDAE*						
Gymnorhina tibicen	Australian magpie			3	O/E	0705
Strepera graculina	Pied currawong			1	O	0694
Family: *CORVIDAE*						
Corvus coronoides	Australian raven			1	O	0930
Family: *CORCORACIDAE*						
Corcorax melanorhamphos	White-winged chough			1+	O	0693
Family: *PASSERIDAE*						
Passer domesticus *	House sparrow			1+	O	0995
Taeniopygia bichenovii	Double-barred finch			1+	O	0655
Family: *HIRUNDINIDAE*						
Hirundo ariel	Fairy martin			1+	O/E	0360
Family: *SYLVIIDAE*						
Arcocephalus stentoreus	Clamourous reed-warbler			1	O	0524
Cincloramphus mathewsi	Rufous songlark			1	W	0509
Family: *STURNIDAE*						
Sturnus vulgaris *	Common starling			1+	O	0999
Acridotheres tristis *	Common myna			1	O	0998

Appendix 3. Actions required in relation to Notifiable Weeds pursuant to the Noxious Weeds Act 2003

Section 8 of the amended Noxious Weeds Act 1993 classifies noxious weeds into 5 weed control classes as follows:

(a) Class 1 - State Prohibited Weeds,
(b) Class 2 - Regionally Prohibited Weeds,
(c) Class 3 - Regionally Controlled Weeds,
(d) Class 4 - Locally Controlled Weeds,
(e) Class 5 - Restricted Plants.

The characteristics of each class are as follows:

(a) Class 1 noxious weeds are plants that pose a potentially serious threat to primary production or the environment and are not present in the State or are present only to a limited extent.
(b) Class 2 noxious weeds are plants that pose a potentially serious threat to primary production or the environment of a region to which the order applies and are not present in the region or are present only to a limited extent.
(c) Class 3 noxious weeds are plants that pose a serious threat to primary production or the environment of an area to which the order applies, are not widely distributed in the area and are likely to spread in the area or to another area.
(d) Class 4 noxious weeds are plants that pose a threat to primary production, the environment or human health, are widely distributed in an area to which the order applies and are likely to spread in the area or to another area.
(e) Class 5 noxious weeds are plants that are likely, by their sale or the sale of their seeds or movement within the State or an area of the State, to spread in the State or outside the State.

A noxious weed that is classified as a Class 1, 2 or 5 noxious weed is referred to in the Act as a "**notifiable weed**".

<u>The relevant sections of the Act that define the actions required in relation to **notifiable weeds** are reproduced below:</u>

<u>Section 15</u>: An occupier of land (other than a local control authority) on which there is a **notifiable weed** must notify the local control authority for the land of that fact within 3 days after becoming aware that the **notifiable weed** is on the land. ***Maximum penalty (for an occupier other than a public authority): 20 penalty units***

<u>Section 16</u>: For the purpose of proving in any prosecution under section 15 (1) that an occupier of land was aware that a **notifiable weed** was located on the land, if it is proved that the occupier or an employee of the occupier or other person using the land ought reasonably to have known that a **notifiable weed** was located on the land, that is evidence that the occupier was aware that it was on the land.

<u>Section 28:</u>
(1) A person (including a public authority) must not sell or purchase:
    (a) any <u>**notifiable weed**</u> material or other <u>noxious weed</u> material prescribed by the regulations, or
    (b) any animal or thing which has on it, or contains, <u>**notifiable weed**</u> material or other <u>noxious weed</u> material prescribed by the regulations, knowing it to be, or to have on it or to contain, any such weed material.
(2) An occupier of land (including a public authority) must not knowingly remove or cause to be removed from the land any animal or thing which has on it, or contains, <u>**notifiable weed**</u> **material** or other <u>noxious weed</u> material prescribed by the regulations. ***Maximum penalty: 50 penalty units.***
(3) <u>Notifiable weed</u> material:
    (a) in subsection (1) extends to the weed material of a weed that is a <u>**notifiable weed**</u> in any part of the State, and
    (b) in subsection (2) is limited to the weed material of a weed that is a <u>**notifiable weed**</u> in that part of the State that includes the land that is relevant for the purposes of that subsection.

<u>Section 29</u>: An occupier of land (including a public authority) must not use or permit the land to be used for the purpose of disposing of, transporting or selling soil, turf or fodder, if the occupier knows, or ought reasonably to know, that there is a weed on the land that is a **notifiable weed** in any part of the State. ***Maximum penalty: 50 penalty units.***

<u>Section 40</u>: An inspector who has reasonable cause to suspect that **notifiable weed** material of a weed that is a notifiable weed in any part of the State is or may be present in an agricultural machine may require the person apparently in charge of the machine to treat the machine immediately, in the manner specified by the inspector, to remove any such weed material.

For further information about notifiable noxious weeds, contact: Weeds Hotline 1800 680 244 or email: <u>weeds@dpi.nsw.gov.au</u> (NSW Department of Primary Industries).

Appendix 4. Project Personnel and Relevant Licenses

REPORT COMPONENT	STUDY TEAM MEMBERS	QUALIFICATIONS
Overall Project Management, Flora Field Surveys, Flora Descriptions, Report Writing	Stefan Rose	B.Sc (Biol. Sci), M.Env.Stud., MAIBiol, MECA
Literature Review	Amy Rowles	B. Sc. (Hons) Biology/Ecology
Report Writing, Figure Preparation	Jenny Lewis	B.Sc (Res. & Env. Mgt.), TAFE Cert II (Conserv. & Land Mgt. Nat. Area Rest.)
Fauna Field Surveys	Narawan Williams	TAFE Cert II (Conserv. & Land Mgt. Nat. Area Rest.)

Relevant licences held by Ecotone Ecological Consultants

TYPE	FOR	LICENCE NO	NAME	DATE VALID TO	ORGANISATION	LOCATION
Animal Research Authority	Vertebrate Fauna Surveys	AW94/082	Brian Wilson	15-Nov-08	Animal care and ethics committee of the Director-General of NSW Agriculture	NSW
Certificate of Approval	Vertebrate Fauna Surveys	DG's ACEC 94/082	Brian Wilson	15-Nov-07		
Licence to	Access NPWS Wildlife Atlas Data Base	CON93002	Brian Wilson	31-Jan-08	NSW Department of Environment and Conservation	
Scientific Licence	Harm/ trap/ release: protected fauna; pick/ hold: native flora	S10555	Brian Wilson Stefan Rose Jenny Lewis Amy Williams Narawan Williams Anne Williams	30-Jun-07		
	As above plus bat banding	S10556	Ray Williams	31-Aug-07		

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