Appendix N

Transport Assessment

Balranald Mineral Sands Project

Transport Assessment

Prepared for Iluka Resources Limited
May 2015

ILUKA

EMM
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Balranald Mineral Sands Project

Transport Assessment

Iluka Trim Reference No: 1646005

Prepared for Iluka Resources Ltd | 1 May 2015

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Balranald Mineral Sands Project

Final

Report J12011RP1 | Prepared for Iluka Resources Ltd | 1 May 2015

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Signature		Signature	
Date	1 May 2015	Date	1 May 2015

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

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Executive Summary

ES1 Project location and transport operations

The Balranald Mineral Sands Project proposes mining and rehabilitation of two linear mineral sand deposits which are located approximately 12 km and 67 km north-west of the town of Balranald.

The location of the mine project area and the proposed mine product haulage routes through Balranald, and Tooleybuc in NSW and Manangatang in Victoria are shown in Figure E.1. The mine products would be a combination of processed heavy mineral concentrate (HMC) and ilmenite. These would be further processed at locations in Victoria and exported.

As there are no rail transport connections to the Balranald area of NSW, road transport using B-Double trucks would be utilised for all the mine product transport within NSW. Potentially, the ilmenite would be transferred to rail transport at Manangatang and the HMC product would be either transferred to rail transport at Hopetoun in Victoria or transported by road the entire route to an existing Iluka mineral processing facility at Hamilton (also in Victoria).

ES2 Project life and workforce

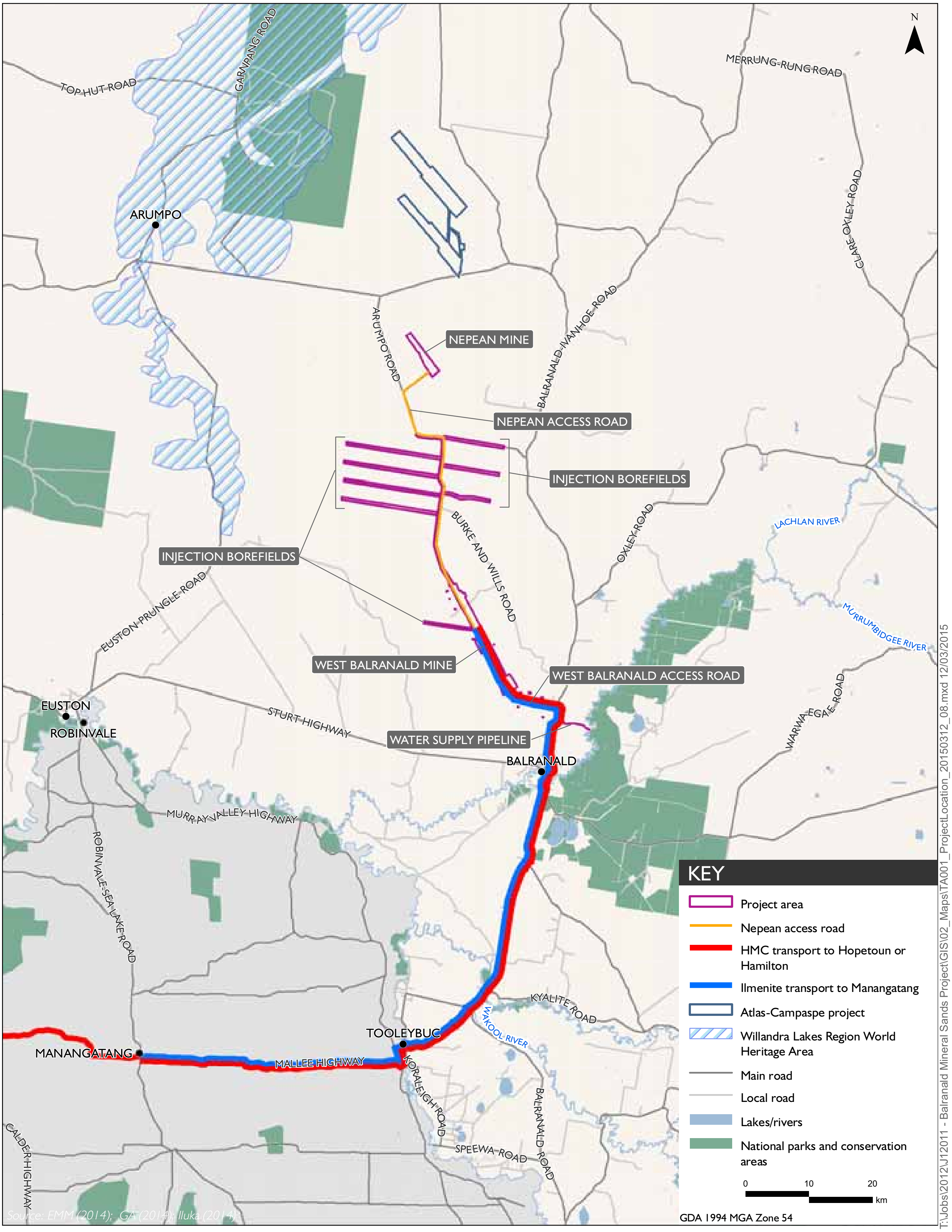
The project would have a life of approximately 15 years including a 2.5 year construction period, and nine years of operations, followed by rehabilitation and decommissioning during the final 3.5 years of the project. The mine is anticipated to employ a peak construction phase workforce (including some of the start-up operations workforce) of approximately 450 people in May 2018 and a subsequent peak operational phase workforce of about 550 people in June 2020.

Due to shift rostering and leave arrangements, the maximum actual workforce at the mine at any given time would be 315 (construction) and 385 (operational) respectively. Due to the relative remoteness of the mine from the nearest major population centres at Swan Hill and Mildura, a very high proportion of these workforces (95%) would be resident at an on- site mine accommodation facility, during the main project construction and operational phases.

The mine accommodation facility would be approximately 11 km north of Balranald, within the mine project area, as shown on Figure E.2. The availability of on-site accommodation would significantly reduce the mine commuting traffic which would otherwise need to use Balranald-Ivanhoe Road and other local roads in the Balranald area for daily commuting to and from the project. The accommodation facility would also generate some local servicing and delivery traffic including some locally based employee and truck traffic and longer distance truck deliveries from regional suppliers for consumables, maintenance and waste removal.

ES3 Project consultation and feasibility studies

A number of design studies and feasibility assessments for the proposed mine road transport operations have been undertaken by Aurecon and other consultants during 2012 - 15. These have included a transport route options study for the mine product haulage, an oversize vehicle routes study for mine construction access, road safety audits for the NSW and Victoria sections of the product haulage route and a haulage route pavement strength review which includes a future road pavement maintenance strategy and costings of proposed works for the product haulage route.



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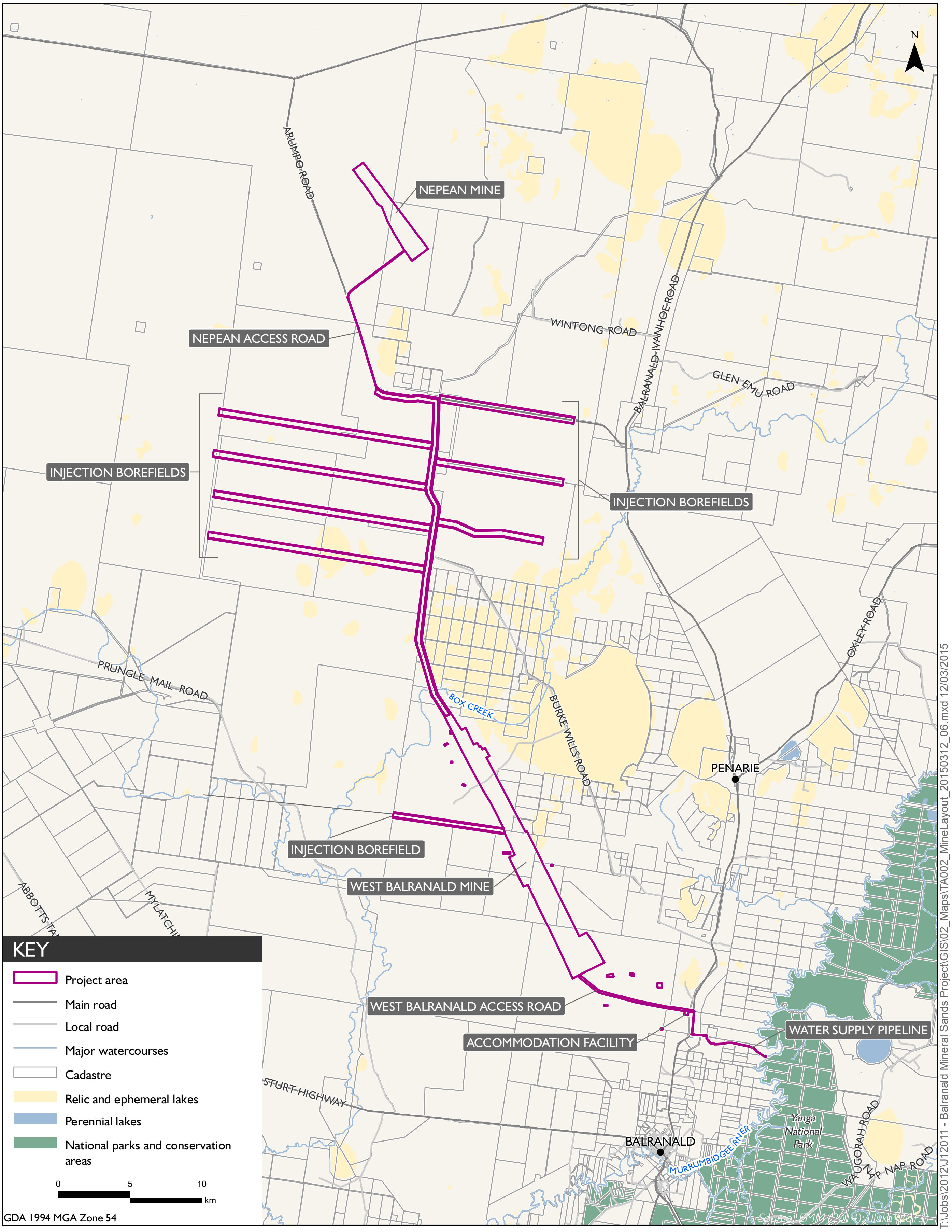
Location of the Balranald Project

Balranald Mineral Sands Project

Traffic Assessment

Figure E.1



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Project area

Balranald Mineral Sands Project
Traffic Assessment
Figure E.2

A series of transport agency workshops were held in Balranald during 2013 and 2014 providing briefings to RMS, VicRoads and the Balranald and Wakool Shire Councils. The results of the initial transport feasibility studies and route assessments were presented at the agency consultation meetings and have been incorporated into this report.

During the later stages of project construction, regular oversize vehicle movements would operate to and from existing Iluka project sites in Victoria to transport mining equipment to the Balranald area. Due to the width restriction at the existing Tooleybuc Bridge, these heavy vehicle movements would generally need to travel via the Murray Valley Highway to Robinvale and via the Sturt Highway, between Euston and Balranald. At a number of intersections, which are primarily local intersections within Balranald township, intersection earthworks (eg fill) would be required to accommodate the swept paths of the trailers for these oversize vehicle movements.

ES4 Traffic impacts on roads and at intersections

This report has assessed the project related traffic impacts for the mine construction traffic at the peak stage of mine construction in 2018 (which included the overlap period of mine construction and operations) and the peak stage of mine operations in 2020. It considered the affected road networks within NSW, within approximately 100 km of the mine. This includes the two proposed mine access roads (West Balranald Access Road and Nepean Access Road).

The Nepean Access Road, would incorporate sections of two existing local roads (Burke and Wills Road and Arumpo Road) which would be upgraded to an appropriate standard to accommodate the proposed mine traffic in combination with the existing local and tourist traffic. Prior to the establishment of the West Balranald access road Iluka may require temporary access along Burke and Wills Road for traffic during the early stages of construction. Iluka would ensure sections are regraded to address induced damage and minimise corrugations, potholes and other surface defects.

The current road widths have been measured for all the major roads and sealed local roads in the area potentially affected by the project traffic. The existing daily traffic volumes for these roads were determined from a combination of historic RMS traffic counts (generally from the year 2006), Aurecon's program of tube traffic counts for the product haulage route in June 2014 and peak hourly traffic surveys for various roads in Balranald township by EMM in October 2014.

The assessment of the project construction and operational stage traffic impacts for the key affected roads and intersections within the Balranald area and along the NSW product haulage route from Balranald to Tooleybuc has been undertaken assuming continuing background locality traffic growth over the years from 2014 to 2018 or 2020 at +2.5% annual growth. This has also included the likely project generated traffic using these routes from the recently approved Atlas-Campaspe Mineral Sands Project which is located in an area further to the north (between Balranald and Ivanhoe) and would use road transport to and from a railhead at Ivanhoe for its product transport operations.

The product haulage operations for the two mines would not generally have cumulative impacts for roads in the Balranald area. However, potential cumulative traffic impacts from the two mineral sands projects have been assessed for the off - site workforce and delivery traffic movements to and from each mine which would be travelling via Balranald from the Swan Hill, Mildura and Tooleybuc directions.

The existing traffic levels of service for the affected roads are generally level of service 'A', with low peak hourly traffic volumes. The only exception is the busiest Sturt Highway urban section (Market Street) through the centre of Balranald either side of the Mayall Street (Balranald-Ivanhoe Road) intersection, which is level of service 'B'. These levels of service will not change with the project generated traffic.

There are no congested intersections within the townships of Balranald or Tooleybuc currently, where the busiest intersections are at Market Street/Mayall Street within Balranald and at Murray Street/Tooleybuc Bridge within Tooleybuc. These intersections are currently at levels of service 'A' during both the morning and afternoon traffic peak hours. However at the Murray Street/Tooleybuc Bridge intersection, the peak hour level of service (which is also affected by the alternating one way traffic operation of the Tooleybuc Bridge) will change to level of service 'B' by 2018 as a result of the background traffic growth independently of the project and there would not be any specific project related traffic capacity impacts at this intersection or any other intersection within either the Balranald or the Tooleybuc townships.

ES5 Traffic safety

The five year historic accident data from RMS for roads in the Balranald LGA and the adjoining Wakool LGA, which cover the NSW haulage route between Balranald and Tooleybuc, has been reviewed to identify potential traffic safety risks for traffic using these routes. These include a potential accident cluster location for fatal traffic accidents on the Sturt Highway approximately 40-50 km west of Balranald and a generally higher incidence of road accidents involving collisions with fauna (primarily Kangaroos) on all routes within Balranald LGA. These traffic safety risks indicate that longer distance workforce commuting traffic for the project should be discouraged, and these risks would be minimised by the provision of an on-site workforce accommodation facility for the project.

ES6 Road pavements

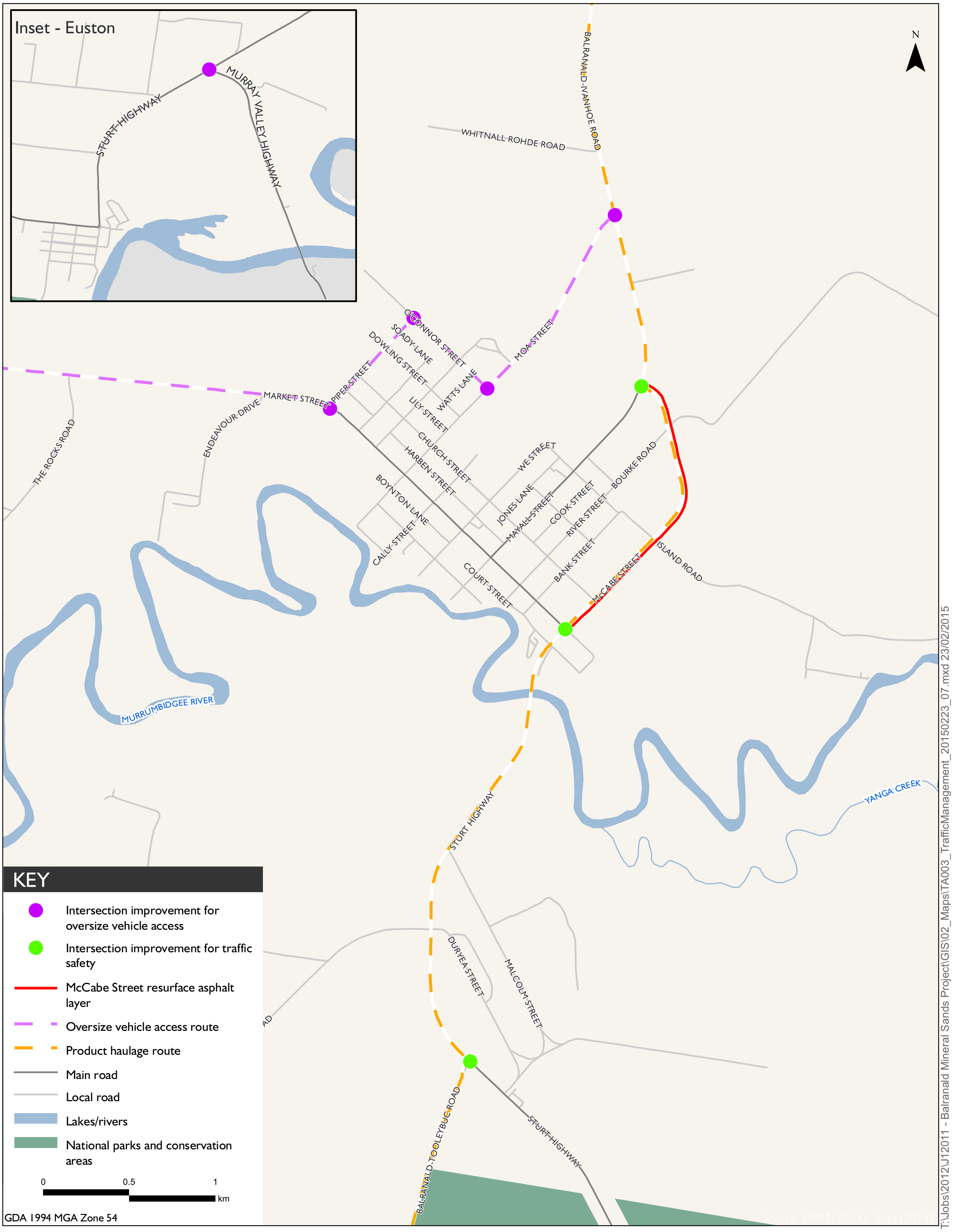
Road pavement impacts would occur on sections of the product haul route within Balranald area, including McCabe Street which provides an eastern heavy vehicle bypass route around the township of Balranald and the sections of Balranald-Ivanhoe Road between the West Balranald mine access road and McCabe Street. An enhanced road pavement maintenance program would be required for the full length of the product haulage route within NSW. A road maintenance strategy and future cost estimates for the product haulage route, including asphalt resurfacing of McCabe Street, is summarised in this report.

At the crossing of the Murray River at Tooleybuc, the Mallee Highway has a single lane bridge which only permits vehicles with the standard general mass limit (GML) axle loadings to use the route. It is likely that within the life of the project (although independently from its specific traffic needs) a replacement two lane bridge may be constructed at Tooleybuc which would permit the mine product haulage trucks to operate with higher mass limit (HML) axle loadings. The implications of the alternative mine transport haulage operation, using trucks with HML axle loading limits, have also been considered in this traffic impact assessment.

ES7 Summary of traffic impacts and mitigation measures

The proposed project related road and traffic safety impact mitigation measures are presented in this report. The proposed locations of the identified traffic safety, road pavement and traffic management impact mitigation measures are shown in Figure E.3 and Figure E.4. Detailed traffic management plans would be prepared for the Balranald Project construction and operational phases. These traffic management plans would provide further details of the identified traffic impact mitigation measures identified in this report.

The plans would document measures to maximise traffic safety for project generated light and heavy vehicle traffic movements, to ensure the compliance of the project traffic movements with applicable road transport legislation and regulations, to appropriately manage potential driver fatigue, and to respond to any product haulage related traffic incident or emergency. Iluka would seek to direct most project heavy vehicle traffic to travel via McCabe Street to minimise the impacts to residential areas.

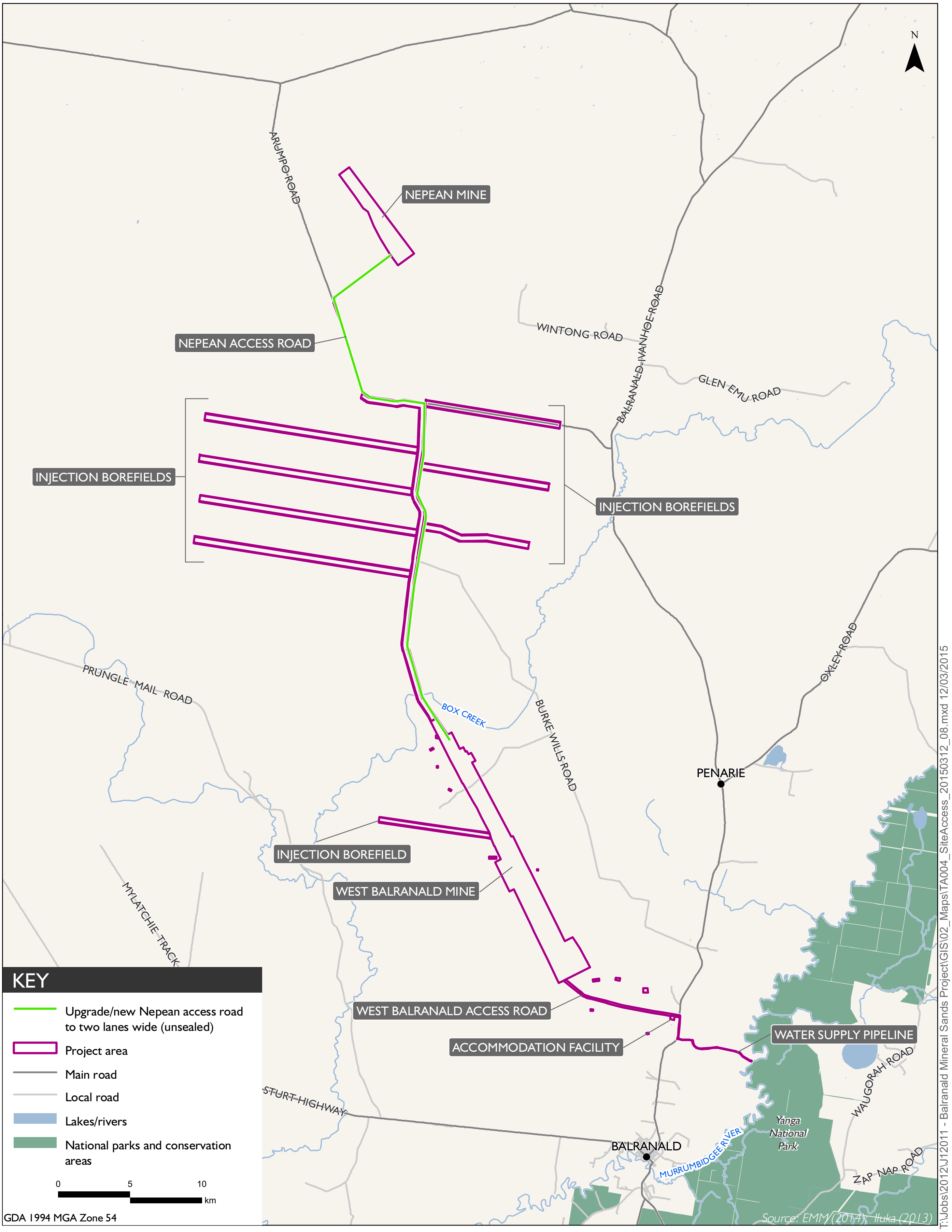


Location of required traffic management and road improvement works at Balranald

Balranald Mineral Sands Project

Traffic Assessment

Figure E.3



Location of road and intersection improvements

Balranald Mineral Sands Project

Traffic Assessment

Figure E.4

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1 Introduction

1.1 Overview

Iluka Resources Limited (Iluka) proposes to develop a mineral sands mine in south-western New South Wales (NSW), known as the Balranald Mineral Sands Project (the Balranald Project). The Balranald Project includes construction, mining and rehabilitation of two linear mineral sand deposits, known as West Balranald and Nepean. These mineral sands deposits are located approximately 12 kilometres (km) and 66 km north-west of the town of Balranald.

Iluka is seeking development consent under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) for the Balranald Project, broadly comprising:

- open cut mining of the West Balranald and Nepean deposits, referred to as the West Balranald and Nepean mines, including progressive rehabilitation;
- processing of extracted ore to produce heavy mineral concentrate (HMC) and ilmenite;
- road transport of HMC and ilmenite to Victoria;
- backfilling of the mine voids with overburden and tailings, including transport of by-products from the processing of HMC in Victoria for backfilling in the mine voids;
- return of hypersaline groundwater extracted prior to mining to its original aquifer by a network of injection borefields;
- an accommodation facility for the construction and operational workforce;
- gravel extraction from local sources for construction requirements; and
- a water supply pipeline from the Murrumbidgee River to provide fresh water during construction and operation.

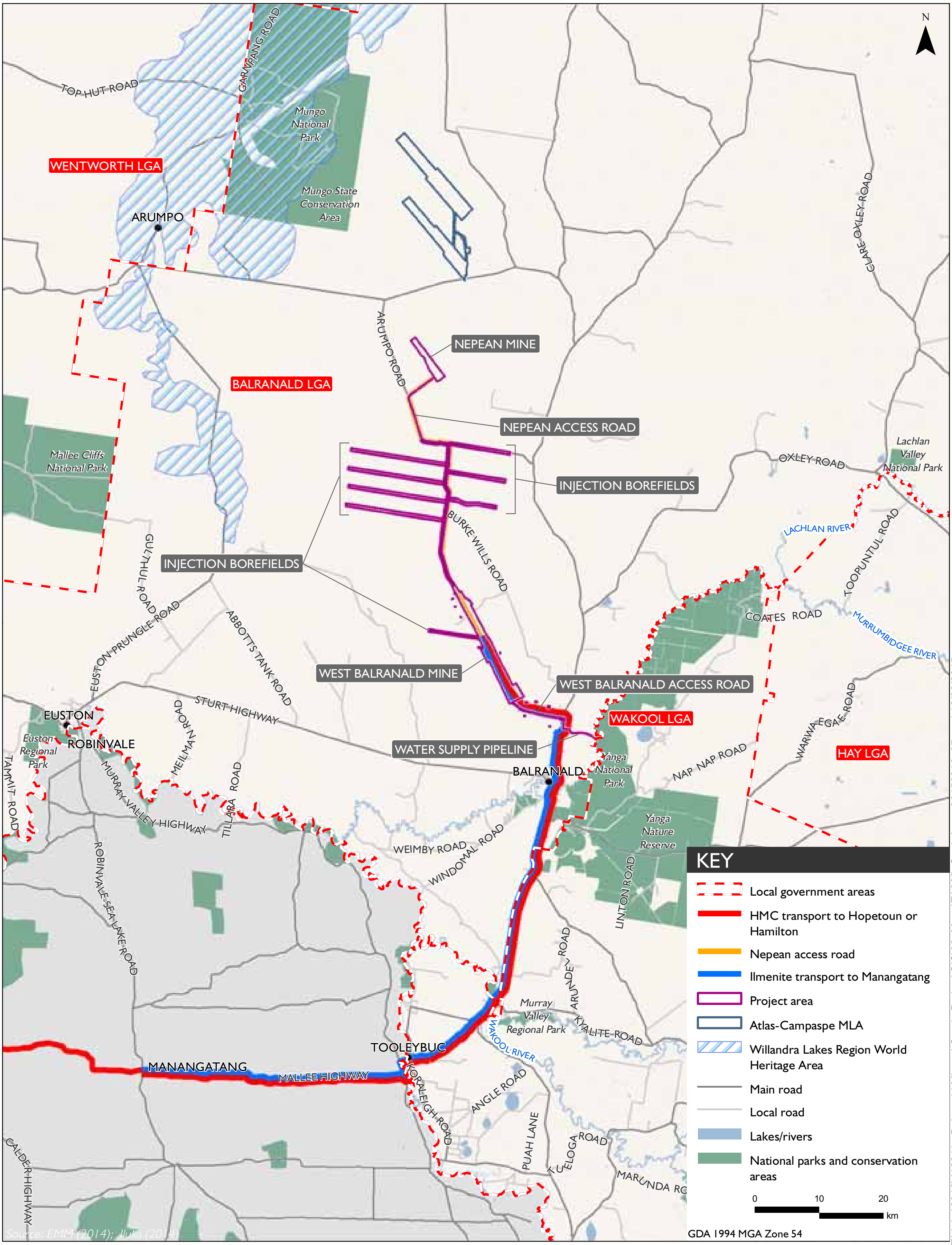
Separate approvals, are being sought for:

- the construction of a transmission line to supply power to the Balranald Project; and
- project components located within Victoria.

The Balranald Project transport study area encompasses and would have effects on the transport networks of several local government areas (LGA) as shown in Figure 1.1, with the relevant transport authorities being Balranald Shire Council, NSW Roads & Maritime and VicRoads.

1.2 Approval process

In NSW, the Balranald Project requires development consent under Part 4, Division 4.1 of the EP&A Act. Division 4.1 specifically relates to the assessment of development deemed to be State significant development (SSD). The Balranald Project is a mineral sands mining development which meets the requirements for SSD.



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Regional context

Balranald Mineral Sands Project
Traffic Assessment
Figure 1.1

An application for SSD must be accompanied by an environmental impact statement (EIS), prepared in accordance with the NSW *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation).

An approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is required for the Balranald Project (with the exception of the transmission line which would be subject to a separate EPBC Act referral process). A separate EIS would be prepared to support an application in accordance with the requirements of Part 8 of the EPBC Act.

1.3 Secretary's environmental assessment requirements

This Transport Assessment (TA) has been prepared to address specific requirements provided in the Secretary's environmental assessment requirements (SEARs) for the SSD application, issued on 2 December 2014 – refer Table 1.1.

Table 1.1 Relevant SEARs for this assessment

Requirement	Section addressed
Accurate predictions of the road and rail traffic generated by the Balranald Project.	Road traffic Sections 4.5.1 and 4.5.2 and Sections 5.1 and 6.1. No rail traffic would be generated in NSW.
An assessment of the capacity of the rail network to accommodate the transport of ore.	No rail traffic would be generated in NSW.
An assessment of potential traffic impacts on the safety and efficiency of the road network.	Sections 5.2, 5.3, 5.4 and 5.5 and Sections 6.2, 6.3, 6.4 and 6.5.
A detailed description of the measures that would be implemented to maintain and/or improve the capacity, efficiency and safety of the road and rail networks in the surrounding area over the life of the Balranald Project.	Section 7.1 and 7.2.

Government agency requirements that inform the SEARs are also addressed in the TA. Table 1.2 outlines the relevant agency requirements.

Table 1.2 Relevant agency requirements

Requirement	Section addressed
Roads and Maritime Services (RMS)	
Existing and expected additional traffic generation.	Section 3.3 for existing traffic volumes and Sections 4.5.1 and 4.5.2 and Sections 5.1 and 6.1 for the future traffic growth.
Cumulative impacts of the total development on the subject site.	Cumulative impacts of the project traffic with other locality traffic growth, including from the Atlas-Campaspe project are discussed in Sections 5.2 and 6.2.
Traffic generation/attraction and trip generation of the development.	Sections 4.5.1 and 4.5.2.
The direction of travel of all vehicles entering and exiting the site including delivery and construction, service and employee vehicles.	Sections 4.5.1 and 4.5.2 and Figures 4.1, 4.3 and 4.4.
Types and volumes of vehicles to access the site.	Sections 4.5.1 and 4.5.2, Section 5.1 and Section 6.1.

Table 1.2 Relevant agency requirements

Requirement	Section addressed
Annual average daily traffic (AADT) and historical trends on key roads.	Sections 3.3 and 3.4 for existing base traffic volumes. Following the recommendation of RMS, a mid range future locality background traffic growth of +2.5% per annum has been used to represent future AADT growth trends.
Peak period traffic volumes and congestion levels at key adjacent intersections.	Sections 3.2, 3.3 and 3.4 (for existing intersection volumes and design standards) and Sections 5.3 and 6.3 (for future intersection volumes and operating conditions).
Impact of generated traffic on the road network and key intersections, the road environment and other major traffic generating developments in close proximity.	Sections 5.1, 5.2 and 5.3 and Sections 6.1, 6.2 and 6.3.
Accident history of the road network in the area.	Section 3.8.
Safety and efficiency of access between the site and the adjacent road network including access location, design and sight distance at access locations.	Sections 4.4, 5.4 and 6.4.
Recommendations to address any impacts on the road network.	Sections 7.1 and 7.2.
The intended ownership and maintenance arrangements for the Nepean access road need to be addressed.	Sections 5.2 and 6.2. Ownership would be a combination of private (for newly constructed roads) and public (for sections of the existing road network).
RMS notes: The manner in which the entrance from the highway is treated has the potential to encourage additional traffic not related to the mining activity to use the road for access north from the Sturt Highway.	No haulage route is proposed to provide any additional connection or alternative travel route to the Sturt Highway.
Transport route assessment guidelines for the transport of materials and specialised construction equipment having consideration for the loads, weights and lengths of haulage vehicles.	Sections 3.1, 3.2 and 3.3. A product haulage options analysis was undertaken to determine the proposed product haulage route (Aurecon 2012).
A full and independent risk analysis and inspection of the route may be required to be prepared and supplied to Roads and Maritime Services (RMS) for comment.	Independent RSAs have been undertaken (see Section 3.8). The NSW RSA is included in Appendix D.
Further analysis and reporting to assess possible damage to, and repair of the route would be required on a regular basis.	Preliminary road pavement condition impacts for the Balranald Project traffic are identified in Sections 5.5 and 6.5. Future pavement monitoring and mitigation measures during the life of the project would be identified through the Balranald Project traffic management mitigation measures summarised in Section 7.1 and 7.2.
An independent RSA of the proposed haulage route, particularly existing intersections and bridge structures, and the adequacy of the route to safely service the development and other road users.	Independent RSAs have been undertaken (see Table 3.8). The NSW RSA is included in Appendix D.
A transport management plan outlining measures to manage traffic related issues generated by the development, potential impacts associated with the development, the works required to the existing road infrastructure, the measures to be implemented to maintain the standard and safety of the road network, and the procedures to monitor and ensure compliance.	Initial road pavement, traffic capacity and traffic safety mitigation measures for the Balranald Project traffic are identified in Sections 7.1 and 7.2. Future road pavement and traffic safety monitoring measures during the life of the project are also identified.

1.4 Purpose of this report

EMGA Mitchell McLennan (EMM) has been commissioned to undertake a TA for the SSD application for the Balranald Project. The TA has been carried out accordance with the SEARs and with reference to the following standards, guidelines and policies:

- *Guide to Traffic Generating Developments* (RTA 2002); and
- *Road Design Guide* (Austroads 2010).

1.5 Applicable legislation

A summary of the NSW and Commonwealth legislation applicable to traffic and transport, which has been considered in this TA, is provided in Table 1.3.

Table 1.3 Legislation applicable to the Balranald Project

Legislation	Application
NSW *Environmental Planning and Assessment Act 1979* (EP&A Act)	Approval for the Balranald Project is sought under the EP&A Act. The development consent for the Balranald Project would generally require the development to be carried out in accordance with the EIS.
NSW *Roads Act 1993*	The *Roads Act 1993* determines road ownership and maintenance responsibilities for roads affected by the Balranald Project transport operations. Permits may also be required under the *Roads Act 1993* for road upgrades.
NSW *Workplace Health and Safety Act 2012*	The *Workplace Health and Safety Act 2012* determines operational safety and safe work practices for staff and contract truck drivers.
NSW *Clean Air Act 2010*	The *Clean Air Act 2010* regulates permissible exhaust emissions for motor vehicles used in transport operations in NSW.
NSW *Road Transport Act 2013*	The *Road Transport Act 2013* defines road rules and penalties for offences for all road transport operations in NSW.
NSW Road Transport (Driver Licensing) Regulation 2008	This regulation determines requirements for driver licensing for all road vehicles operating in NSW.
Commonwealth Heavy Vehicle Law 2014 (HVNL) and Regulations	The HVNL and regulations govern heavy vehicle operations in all states in Australia including the issuing of permits for the vehicles and routes used for oversize (or 'over dimensional') vehicle movements.

1.6 Summary of the transport assessment methodology

This report addresses the road transport related SEARs for the Balranald Project, including consideration of the *RTA Guide to Traffic Generating Developments* (RTA 2002) and current road and intersection design standards in the *Road Design Guide* (Austroads 2010).

This report incorporates the findings of the following transport investigations:

- a product haulage options analysis to determine the proposed product haulage route undertaken by Aurecon (2012);
- a feasibility road safety audit (RSA) for the mine access and haulage route undertaken by Traffic Works in November 2012 (Appendix D);

- preliminary road pavement inspections and structural reviews for the proposed haulage route, which were undertaken by Aurecon (Aurecon 2015);

- an assessment of oversize vehicle routes, primarily for the transport of mining equipment from existing Iluka mine sites in Victoria to Balranald, was undertaken by Aurecon (2012);

- Balranald Project transport consultation meetings held in Balranald between Iluka, BSC, RMS and VicRoads in October 2013, April 2014 and October 2014; and Balranald Project transport consultation meetings held with Swan Hill Rural City Council and Wakool Councils in November 2014.

This TA report considers roads within an approximate 100 km radius of the Balranald Project that would potentially be affected by car, truck and bus movements during the Balranald Project's construction and operational phases.

Workforce vehicle movements were estimated with consideration of the likely residential origins of the Balranald Project workforce, including those residing at the Balranald Project accommodation facility in the project area, as described in the *Balranald Mineral Sands Project Social Assessment* (EMM 2014). These locations have been used to determine the transport routes which would be used by the construction and operational workforces.

Construction and operational phase truck traffic volumes and transport routes were determined by investigations engaged by Iluka as part of mine planning studies.

The existing traffic levels on the affected road network were estimated using the following:

- a traffic count program undertaken in June 2014 (Aurecon 2014) at six locations, including the Balranald-Ivanhoe Road, McCabe Street, the Sturt Highway and the Balranald-Tooleybuc Road;

- RMS South Western Region traffic count data (RTA 2006), including AADT counts, for the Sturt Highway and Balranald Road for 2006 and for existing Tooleybuc Bridge (MR 694) for February 2014; and

- hourly traffic counts on the local roads around the Balranald Project area and selected roads and intersections in Balranald, undertaken on 29 and 30 October 2014 by EMM.

The road network surface condition inventory and defects were surveyed for the product haulage route in June 2014 (Aurecon 2015), in accordance with Austroads recommended methodology for pavement visual inspections. The current sealed widths, surface conditions and shoulder conditions of all potentially affected roads were also confirmed by field inspections by EMM in October 2014.

The potential project operational stage road pavement impacts were determined by Aurecon for four potential Iluka product road haulage scenarios which correspond to either maximum or minimum future product haulage, using vehicles with either general mass limit (GML) or higher mass limit (HML) axle loadings.

The maximum and minimum product haulage limits will correspond to either heavy mineral concentrate (HMC) and ilmenite product transport or just HMC. The use of either GML or HML axle loading vehicles will depend on whether the Tooleybuc Bridge is replaced during the life of the project as the bridge does not currently accommodate the HML axle loading vehicles.

The project operational stage traffic capacity assessment for the affected roads and intersections has considered only the potential maximum daily truck movements scenario (ie transport of both HMC and Ilmenite and the use of GML axle loading vehicles).

There is the potential for cumulative traffic impacts from the Balranald Project and Atlas-Campaspe Mineral Sands Project to occur from the combined construction and subsequent operation of these two mines. This may result in increased road traffic on certain roads (primarily the Balranald-Ivanhoe Road). These potential cumulative impacts are considered in combination with other locality background traffic increases in the Balranald area Section 5.2 and Section 6.2 of this traffic impact assessment.

The proposed road and intersection improvements in Chapter 7 would address all of the identified traffic safety, level of service, road pavement and maintenance impacts from the Balranald Project traffic during the construction and operational phases. This would include negotiating equitable road maintenance agreements with the BSC and RMS to proportionally fund road maintenance requirements for roads affected along the product haulage route.

2 Agency consultation

2.1 Consultation

Iluka has maintained ongoing consultation with BSC, RMS and VicRoads to identify and discussing potential traffic and transport impacts associated with the Balranald Project. There have been three key workshops with these agencies. A summary of the topics discussed and outcomes of the three workshops in October 2013, April 2014 and October 2014 is detailed in Table 2.1 in relation to Balranald Project activities on roads in NSW.

Table 2.1 Transport workshops – summary of discussions

Workshop	Description of key themes discussed
October 2013 **Discussions regarding proposed transport routes**	Iluka gave a status update for the Balranald Project and outcomes of the pre-feasibility study along with elements requiring further work during the detailed feasibility study to occur in 2013/2014, and presented the proposed haulage routes for HMC and ilmenite.
	The three agencies (RMS/VicRoads/BSC) agreed in principle to Iluka's proposed haulage routes and traffic assessment/risk assessment process completed to date and provided additional background/context relating to asset management, Robinvale Bridge upgrades and high mass limit vehicles and oversize vehicle movements from Victoria to Balranald.
April 2014 **Discussions regarding project related road network and safety audit findings**	Iluka gave a status update for the Balranald Project and key elements requiring further work, and outlined the key actions from the transport workshop held in October 2012 including the regional freight strategy, pavement condition assessment of McCabe Street, distribution of draft traffic assessment and road safety audit.
	Key matters discussed included: • confirmed that 2% traffic growth per annum was acceptable and also requested 3% be assessed; • traffic data to separate out heavy vehicle volumes; • traffic generation to consider regional movements to the project area; • the need to record road pavement width given higher potential for blow outs at the edge of seal from increased heavy vehicle traffic loading; • consideration of additional McCabe Street road works (eg pavement treatment/road geometry/cross road intersections); and • consideration of a Haulage Management Plan to address driver/vehicle/product movement procedures.
October 2014 **Discussions regarding project route pavement condition assessment**	Iluka gave a status update for the Balranald Project and the key findings of recent technical studies including pavement condition assessment, traffic data surveys, predicted design traffic / axle loading and rehabilitation treatment framework to address road safety and pavement maintenance.
	Key matters discussed included: • Tooleybuc Bridge upgrade / Higher Mass Limits and consideration of alternative predicted traffic / axle loading; • RMS and VicRoads rehabilitation treatment and periodic road maintenance programs; • pavement surveys completed by RMS and VicRoads to validate condition assessment findings; • the McCabe Street road alignment and pavement condition treatment; and • State road funding / grant opportunities.

Table 2.1 Transport workshops – summary of discussions

Workshop	Description of key themes discussed
November 2014 **Discussions regarding project, traffic and transport – Wakool Shire Council & Swan Hill Rural City Council**	Iluka gave a status update for the Balranald Project and outlined the technical traffic and transport studies completed for product haulage, road safety, pavement condition and transport assessment.
	Key matters discussed included: • proposed product haulage route; • road safety audit findings; • pavement condition assessment; • incident management/diversions; • Tooleybuc Bridge upgrade; • Victorian Rail Strategy; • potential sources of limestone and aggregate; and • ongoing engagement with Councils.

2.2 Future replacement of the Tooleybuc Bridge

RMS has identified that it is currently investigating options for replacement of the existing single lane bridge crossing the Murray River at Tooleybuc (the Tooleybuc Bridge). Iluka understands that RMS are consulting with key stakeholders and the Tooleybuc community on a number of bridge alignment options with consultation and environmental studies to be completed during 2015. At the time of preparing this TA a timeframe for replacement of the bridge is not known and may or may not coincide with the construction and / or operational phases of the Balranald Project.

It is understood that a replacement of the existing Tooleybuc Bridge would permit higher axle loadings to be used in the future by vehicles crossing the bridge. For the purpose of this TA report for the Balranald Project and associated road pavement assessment (Aurecon 2015) Iluka's base case assessment on predicted heavy vehicle traffic volumes and future design life axle loadings for the road pavements has been prepared on the current general mass limits (GML) which are permitted by the bridge.

For comparative road pavement assessment, predicted heavy vehicle traffic volumes and future design life axle loadings has also been considered for future higher mass limits (HML) should they be permitted on the bridge during the construction and / or operational phases of the Balranald Project (refer Section 6.5).

3 Existing road and traffic conditions

3.1 The locality

The main urban centres near the Balranald Project are, in NSW, Balranald (1,159 persons) and Euston (600 persons), and in Victoria, the rural city of Swan Hill (10,429 persons) and smaller rural townships and settlements in the Swan Hill LGA, which include Nyah, Manangatang, Robinvale, Euston and Lake Boga. These have a combined population of 10,022 persons.

Balranald-Ivanhoe Road connects the project area to the Sturt Highway at Balranald. The Sturt Highway links Balranald to Robinvale / Euston and Mildura to the west, and Hay and Wagga Wagga to the east (Figure 1.1).

3.2 Existing road network

A description of the road network that may be used by the Balranald Project within an approximate 100 km radius of the project area is provided in the following sections. Photographs showing the existing typical road width and construction standards for these roads are included in Appendix A.

The existing daily traffic usage of the road network in the vicinity of the Balranald Project is shown in Figure 3.1.

3.2.1 Balranald-Ivanhoe Road

Balranald-Ivanhoe Road is classified as a Main Road (MR 67) and is under local (BSC) jurisdiction. It is known as Mayall Street within Balranald town, and runs for approximately 230 km from the Sturt Highway at Balranald, generally north via Hatfield, to the Cobb Highway at Ivanhoe. An 11 km section of Balranald-Ivanhoe Road to the south of its intersection with Burke and Wills Road would be used by Balranald Project traffic and has one lane in each direction, with no edge markings and no sealed shoulders.

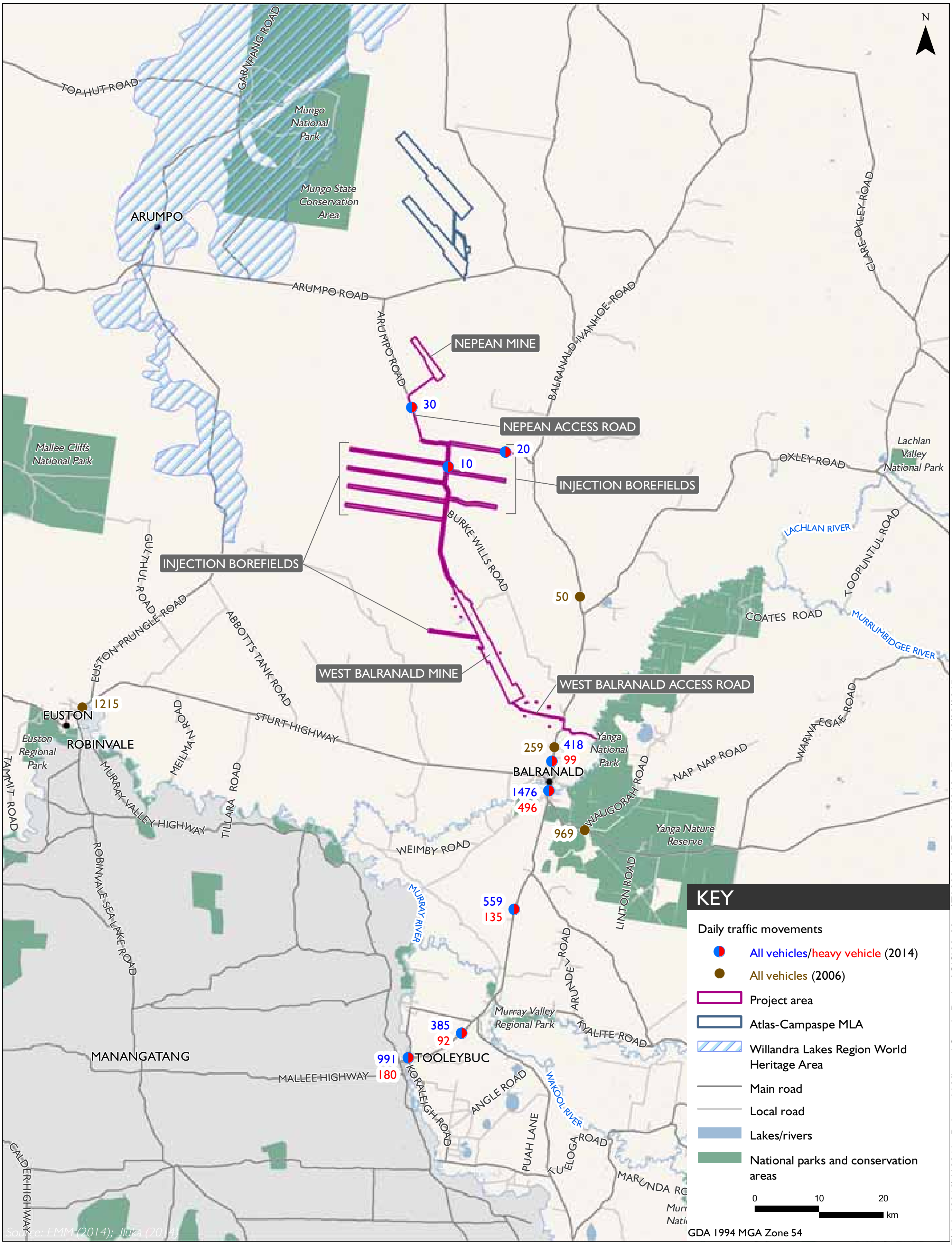
Balranald-Ivanhoe Road is an approved B-Double route, and has a 100 km per hour (km/hr) speed limit outside Balranald town (north of McCabe Street) and is proposed to be used for product haulage from the mine site.

3.2.2 Sturt Highway

The Sturt Highway is classified as a Highway (SH 14) and is under State (RMS) jurisdiction. It extends from the Hume Highway at Lower Tarcutta through Wagga Wagga, Narrandera, Hay, Balranald, Euston and Buronga to the bridge over the Murray River at Mildura. This road is an approved B-Double route. The Sturt Highway is known as Market Street within Balranald town.

A short section of the Sturt Highway, south of Balranald would be utilised as part of the product haulage route for the Balranald Project. Other sections of the Sturt Highway to the west and east of Balranald would also be used by other Balranald Project workforce and delivery truck traffic.

The Sturt Highway has a good alignment in the vicinity of Balranald with one lane each direction and sealed shoulders. It is subject to a speed limit of 110 km/hr outside Balranald town, reducing to 50 km/hr along Market Street. The Sturt Highway section between McCabe Street and the Balranald-Tooleybuc Road is proposed to used for product haulage.



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Existing daily traffic volumes

Balranald Mineral Sands Project

Traffic Assessment

Figure 3.1

3.2.3 Balranald-Tooleybuc Road

Balranald-Tooleybuc Road (also known as the Mallee Highway) is classified as a Main Road (MR 694) under State (RMS) jurisdiction. It is the main traffic route between Balranald and Victoria. It extends from the Sturt Highway, 2.8 km south of Balranald, to the existing Tooleybuc Bridge over the Murray River at Tooleybuc. The road is an approved B-Double route. It is subject to a speed limit of 100 km/hr outside Tooleybuc town, reducing to 50 km/hr within Tooleybuc.

Balranald-Tooleybuc Road is proposed to be used for product haulage from the mine site. The 54 km length of the road from the Sturt Highway to Tooleybuc would be utilised as part of the product haulage route for the Balranald Project. This road generally has two lanes with marked edge lines which define narrow sealed shoulders, although there are two bridges along this section where there are no shoulders.

The existing Tooleybuc Bridge is a single lane bridge located within the town of Tooleybuc providing access across the Murray River between NSW and Victoria. The bridge can accommodate large vehicles up to and including B-Double vehicles operating under GML.

3.2.4 Burke and Wills Road

Burke and Wills Road is located to the west of the Balranald-Ivanhoe Road, approximately 15 km north of Balranald town, and is under local (BSC) jurisdiction. With the exception of the approach to the intersection with Balranald-Ivanhoe Road which is sealed, the remaining 46 km length of Burke and Wills Road is generally a formed, un-sealed road, signposted as suitable for dry weather use only.

The road width is variable with two trafficable lanes generally for the southern 22 km section and a single trafficable lane for the remaining 24 km section to the intersection with Arumpo Road. There is a short sealed section where there is a bend along the route, approximately 4 km west of the intersection of Burke and Wills Road and Balranald-Ivanhoe Road. There is no sign-posted speed limit for Burke and Wills Road, which indicates that the normal rural speed limit of 100 km/hr applies.

Sections of Burke and Wills Road are likely to be used to provide temporary access for traffic during the early stages of construction prior to the establishment of the West Balranald access road (see Section 4.2.3). Part of Burke and Wills Road (0–12 km south of Arumpo Road) is proposed to be incorporated as part of the Nepean access road (see Section 4.2.3).

3.2.5 Arumpo Road

Arumpo Road (also known as Box Creek Road) is located to the west of the Balranald-Ivanhoe Road approximately 53 km north of Balranald town, and is under local (BSC) jurisdiction. It is generally an unsealed road that connects to the Burke and Wills Road, approximately 13 km west of the Balranald-Ivanhoe Road. To the west, Arumpo Road connects to the Silver City Highway near Buronga, east of Mildura. Arumpo Road provides access to the Mungo National Park.

There is no sign posted speed limit for Arumpo Road, which indicates that the normal rural speed limit of 100 km/hr applies.

Sections of Arumpo Road may be used by construction traffic during construction of the Nepean mine, which is anticipated to commence from approximately Year 5 of the operational phase. Part of Arumpo Road (0 - 10 km west of its intersection with the Burke and Wills Road) is also proposed to be used as part of the Nepean access road (see Section 4.2.3).

3.2.6 Piper Street

Piper Street in Balranald town forms the western boundary of the town and runs north from the Sturt Highway to O'Connor Street. Piper Street is a local road under local (BSC) jurisdiction. It has a narrow two lane seal with no road markings and vegetation growing along its shoulders. The road provides direct access to a mix of residential and industrial properties. This road is an approved B-Double route between the Sturt Highway and O'Connor Street. A 50 km/hr urban speed limit for Balranald applies to Piper Street and O'Connor Street.

The route via Piper Street and O'Connor Street, west of Moa Street is proposed to be used during the Balranald Project construction and operational phase as an oversize vehicle access route and general vehicle access route around the town of Balranald.

3.2.7 Moa Street

Moa Street is a local road under local (BSC) jurisdiction. It runs north from the Sturt Highway through to the Balranald-Ivanhoe Road. The road is two lanes wide with a variable sealed width. It is wider at its southern end towards the Sturt Highway. There are generally no road markings or sealed shoulders. This road is an approved B-Double route between the Sturt Highway and Balranald-Ivanhoe Road.

A 50 km/hr urban speed limit applies to Moa Street south of O'Connor Street, and increases to 80 km/hr between O'Connor Street and Balranald-Ivanhoe Road.

Moa Street is proposed to be used during both construction and operational phases of the Balranald Project as an oversize and general vehicle access route around the town of Balranald.

3.2.8 O'Connor Street

O'Connor Street is a local road under local (BSC) jurisdiction that links Piper Street to Moa Street. It comprises a narrow two lane wide seal with no road markings or sealed shoulders. The road provides access to the BSC Maintenance Depot, located approximately mid-way along its length. It is an approved B-Double route between Piper Street and Moa Street. A 50 km/hr urban speed limit for Balranald applies to O'Connor Street.

O'Connor Street west of Moa Street is proposed to be used during the Balranald Project construction and operational phases as an oversize vehicle and general vehicle access route around the town of Balranald.

3.2.9 McCabe Street

McCabe Street is a local road under local (BSC) jurisdiction. It runs to the south-east of Balranald town providing access to industrial areas and the Balranald Base Hospital located in the south-east of the town. The road is generally two lanes wide with no lane marking or sealed shoulders.

The road is an approved B-Double route between the Sturt Highway and Balranald-Ivanhoe Road, and is also used as a heavy vehicle bypass route for traffic travelling to and from destinations via the Sturt Highway and Balranald Tooleybuc Road, south and east of Balranald. An 80 km/hr urban speed limit for Balranald applies to McCabe Street.

3.2.10 Victoria transport routes

i Over dimensional vehicle routes

During the Balranald Project construction phase, oversize vehicle movements would transport items of mining machinery and equipment to the project area from Iluka's existing Woornack, Rownack and Pirro (WRP) mine near Ouyen, Victoria.

As the existing Tooleybuc Bridge is only one lane wide, oversize vehicles are proposed to travel via the Murray Valley Highway Bridge at Robinvale, and the Sturt Highway between Robinvale/Euston to Balranald (refer to Section 4.5 and Figure 4.1).

In the vicinity of Balranald, other route restrictions such as overhead power lines would constrain these vehicles to use a designated oversize vehicle access route via Piper Street, O'Connor Street and Moa Street, when travelling between the Sturt Highway west of Balranald and the Balranald-Ivanhoe Road to the project area (refer to Section 5.2 and Figure 5.1).

ii Product transport routes

HMC and ilmenite would be transported by trucks from the West Balranald mine to destinations in Victoria. The primary transport of HMC would be by B-double vehicles to Iluka's existing rail loading facility at Hopetoun in Victoria. The route is through Tooleybuc to the NSW/Victoria border at the existing Tooleybuc Bridge, then west into Victoria via the Mallee Highway to Manangatang and Ouyen (including a short connecting section which uses the Murray Valley Highway at Piangil) then via the Calder Highway, Sunraysia Highway and Henty Highway to Hopetoun.

Iluka's WRP mine currently transports HMC to Hopetoun via the Calder Highway, Sunraysia Highway and Henty Highway. Transport movements associated with WRP will cease prior to the operation of the Balranald Project with heavy vehicles from Balranald to substitute existing movements along these public road networks.

The transport of Ilmenite would be by either B-double trucks (in bulk) or containerised on flat-bed trucks. Ilmenite would be transported to a proposed future rail loading facility in Manangatang which is approximately midway between Piangil and Ouyen on the Mallee Highway in Victoria.

The existing road width and pavement condition for new sections of product haulage within Victoria (Tooleybuc to Manangatang) have been investigated in preliminary road pavement condition assessments for the Balranald Project (Aurecon 2015) and have been found to be adequate at all locations to accommodate the proposed Balranald Project traffic.

3.3 Existing traffic conditions

3.3.1 Traffic characteristics

In the immediate vicinity of the project area, on existing roads such as the Burke and Wills Road and Arumpo Road, traffic is primarily local farm traffic with some tourist traffic including campervans and vehicles towing caravans which are travelling on a designated tourist route via Lake Mungo. On the Balranald town roads, traffic is primarily local traffic on most roads except for the Sturt Highway, Balranald Ivanhoe Road and McCabe Street, which carry significant proportions of heavy vehicles, including many B-Double type trucks by-passing the Balranald urban area.

Moa Street, O'Connor Street and Piper Street within Balranald town provide a heavy vehicle bypass route between Balranald-Ivanhoe Road and the Sturt Highway to the west of town which bypasses most of the residential areas.

Outside the town of Balranald the major road network, which consist of the Sturt Highway, Balranald-Ivanhoe Road and Balranald-Tooleybuc Road, carries high proportions of heavy vehicle traffic (up to 30-40% of all traffic on some sections), much of which is long distance or interstate freight traffic. A majority of this traffic comprises large B-Double type trucks with up to nine axles per vehicle.

3.3.2 Existing traffic volumes

The existing daily and peak hour traffic volumes on the major and local roads considered in this TA report have been determined from a recent program of tube traffic counts (Aurecon, 2015) and other annual average daily traffic (AADT) data sourced from RMS traffic surveys.

RMS traffic counts for roads in the Balranald and Tooleybuc areas (2006) are included, together with a more recent RMS traffic survey for the Tooleybuc Bridge (February 2014). This data is summarised in Appendix B.

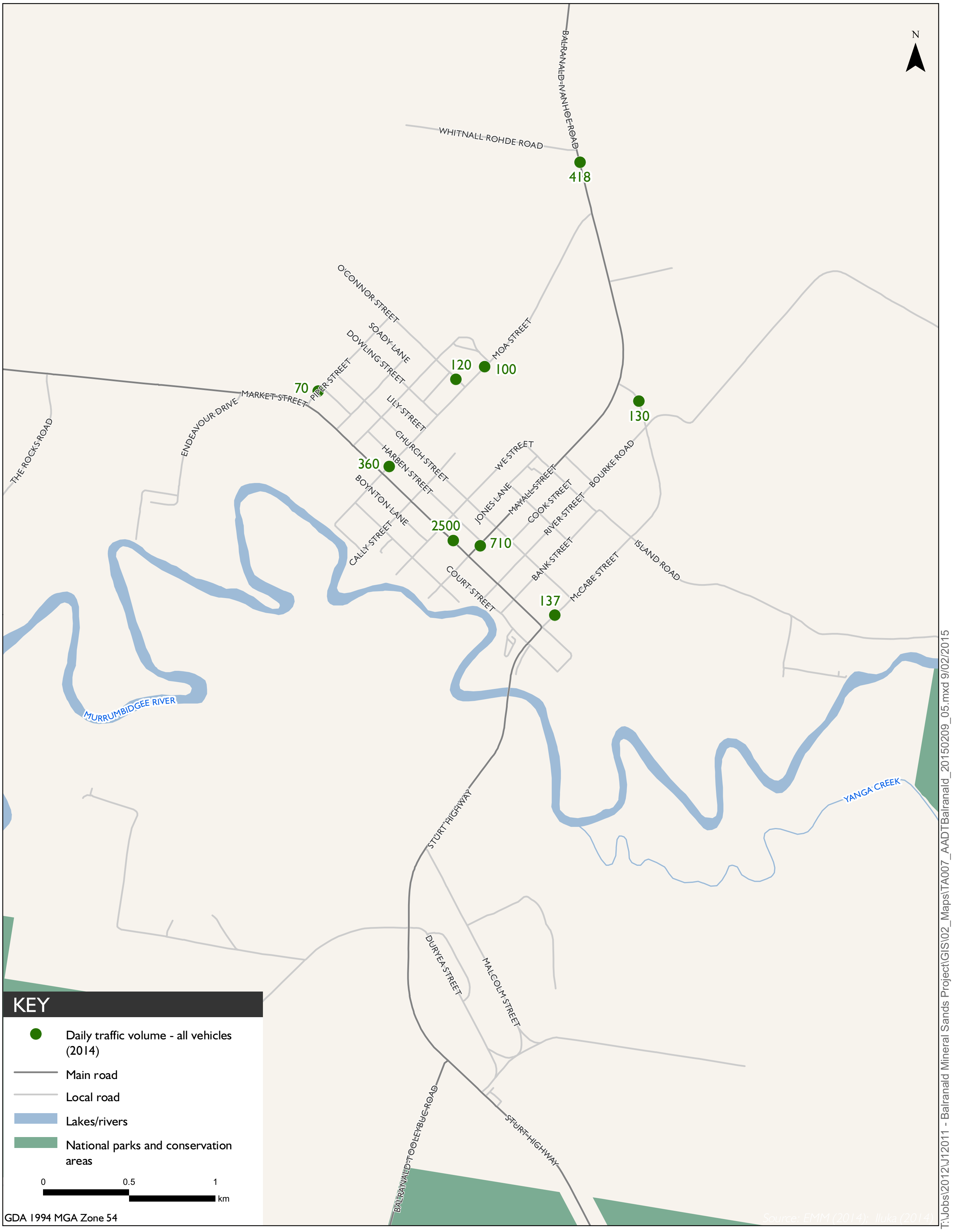
Other daily traffic volumes for the Balranald Project area roads were estimated from:

- midday and daytime traffic usage of the locals roads (Burke and Wills Road and Arumpo Road) which was observed by EMM on 30 October 2014; and
- morning and afternoon peak hour traffic volumes for urban roads within Balranald town, including Moa Street, Piper Street, O'Connor Street and Mayall Street, which were surveyed by EMM on 29 and 30 October 2014.

The daily traffic volumes for all roads and the more limited surveys of hourly traffic volumes are listed in Table 3.1 and Table 3.2 and illustrated graphically by Figure 3.1 and Figure 3.2.

The Sturt Highway, Balranald-Ivanhoe Road and Balranald-Tooleybuc Road all carry relatively high proportions of heavy vehicle traffic (between 24–34% of all traffic). On the local BSC-maintained roads within and around Balranald, the volumes and proportions of heavy vehicle traffic are generally much lower, with the exception of McCabe Street which carries 41% heavy vehicles.

On an urban section of the Sturt Highway (Market Street) within Balranald town, an additional RMS traffic survey in 2006 recorded a daily traffic volume of 3,381 axle pairs. This surveyed daily traffic volume in axle pairs is equivalent to approximately 2,500 actual vehicles. There is a high proportion of trucks using the Sturt Highway, including many B-Double type trucks with up to nine axles per vehicle.



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ILUKA

Balranald town daily traffic volumes

Balranald Mineral Sands Project

Traffic Assessment

Figure 3.2

Table 3.1 Existing daily traffic and heavy vehicle volumes

Road name	Survey year	Average daily traffic		Proportion of heavy vehicles (%)
		Total – all vehicles	Heavy vehicles	
Balranald-Ivanhoe Road (north of Oxley Road)	2006	50	NA	NA
Balranald-Ivanhoe Road (5 km north of Sturt Highway)	2006	259	NA	NA
Balranald-Ivanhoe Road (north of Moa Street)	2014	418	99	24
Mayall Street (north of Market Street)	2014	710*	NA	NA
McCabe Street (southern end)	2014	137	56	41
Sturt Highway (1 km south of Balranald)	2014	1,476	496	34
Sturt Highway (east of Balranald-Tooleybuc Rd)	2006	969	NA	NA
Sturt Highway (Euston, east of Murray Bridge Road)	2006	1,215	NA	NA
Balranald-Tooleybuc Road (northern section)	2014	559	135	24
Balranald-Tooleybuc Road (southern section)	2014	385	92	24
Balranald-Tooleybuc Road (at existing Tooleybuc Bridge)	2014	991	180	18
Arumpo Road (western section)	2014	30*	NA	NA
Arumpo Road (eastern section)	2014	20*	NA	NA
Burke and Wills Road (northern end)	2014	10*	NA	NA
Burke and Wills Road (southern end)	2014	20*	NA	NA
Piper Street (at Sturt Highway)	2014	70*	NA	NA
Moa Street (at Sturt Highway)	2014	360*	NA	NA
Moa Street (north of O'Connor Street)	2014	100*	NA	NA
O'Connor Street (west of Moa Street)	2014	120*	NA	NA

Source: *RMS and Aurecon daily traffic surveys and estimates for local roads determined from EMM hourly traffic counts.*

Notes: **Daily traffic volume is estimated from EMM hourly traffic volume surveys.*

NA = No heavy vehicle information is available from the traffic surveys.

Hourly traffic volumes were obtained from tube counts (Aurecon 2015) and a limited number of hourly traffic surveys undertaken by EMM on roads within Balranald town on 29 and 30 October 2014.

These hourly traffic volumes are summarised in Table 3.2.

Table 3.2 Summary of surveyed peak hourly traffic volumes for selected roads

Road	Early morning hourly volume 6–7 am	Morning peak hourly volume 7–8 am	Morning peak hourly volume 8–9 am	Early afternoon hourly volume 2–3 pm	Afternoon peak hourly volume 3–4 pm	Afternoon peak hourly volume 4–5 pm
Hourly volumes from tube surveys						
Balranald-Ivanhoe Road (north of Moa Street)	24	22	30	31	36	42
McCabe Street (southern end)	3	5	12	11	10	11
Sturt Highway (south of Balranald)	35	64	83	104	111	109
Balranald-Tooleybuc Road (northern section)	12	20	34	47	45	44
Balranald-Tooleybuc Road (southern section	7	19	21	34	31	33
Tooleybuc Bridge (existing)	39	62	79	73	79	77
Hourly volumes from EMM surveys						
Piper Street (north of Sturt Highway)	4	-	-	-	10	-
Moa Street (north of Sturt Highway)		26	-	-	46	-
Moa Street (north of O'Connor Street)	11	-	-	8	-	-
O'Connor Street	6	-	-	17	-	-
Mayall Street (north of Market Street)	-	-	60	-	-	82
Market Street (west of Mayall Street)	-	-	208	-	-	284

3.4 Traffic capacity standards

3.4.1 Levels of service

Daily and peak hourly traffic volume standards for major rural roads are set by the RMS's *Guide to Traffic Generating Developments* (RTA 2002) (the RMS guideline). The RMS guideline defines six Levels of Service for rural roads:

- **Level of Service A:** The top level of service is a free flow condition in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high and the general level of comfort and convenience provided to traffic is excellent.

- **Level of Service B:** This level of service is termed stable flow and drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream, although the general level of comfort and convenience for traffic is a little less than that of Level of Service A.

- **Level of Service C:** This level of service is also in the stable flow zone, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience for traffic declines noticeably at this level.

- **Level of Service D:** This level of service is close to the limit of stable flow, approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor and small increases in traffic flow would generally cause operational problems.

- **Level of Service E:** This occurs when traffic volumes are at or close to capacity and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream would cause a traffic-jam.

- **Level of Service F:** This service level is termed forced flow. With it, the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs and queuing and delays result.

In most cases, there is little practical difference between the traffic operating conditions for Level of Service A and B on rural roads. The maximum hourly traffic volume standards are only defined in the RMS guideline for rural roads for Levels of Service B to E. However, more detailed calculations are able to be made by reference to the *Austroads Guide to Traffic Engineering Practice–Part 2 Roadway Capacity* (Austroads 1988).

For major rural highways such as the Sturt Highway and Balranald-Tooleybuc Road, the levels of service are influenced by the typical road design and traffic operating characteristics for these roads, which are as follows:

- typical lane width is 3.3 to 3.5 m;

- typical shoulder width is 2.0 m (0.5 to 1.0 m sealed);

- typical terrain is level, with no overtaking for 20% of route length;

- 20–30% of traffic is heavy vehicles; and

- weekday peak hour traffic is approximately 8% of average daily traffic.

These route operating characteristics define the typical hourly and daily traffic volumes ranges for these roads for each level of service with are summarised in the RMS guideline (RTA 2002). For the Sturt Highway and Balranald-Tooleybuc Road, these traffic volume ranges are:

- Level of Service A or B, up to 420 vehicles per hour (5,250 vehicles per day);

- Level of Service C, range 420–690 vehicles per hour (5,250–8,620 vehicles per day);

- Level of Service D, range 690–1,140 vehicles per hour (8,620–14,250 vehicles per day);

- Level of Service E, range 1,140–1,880 vehicles per hour (14,250–23,500 vehicles per day); and

- Level of Service F, over 1,880 vehicles per hour (23,500 vehicles per day).

On the rural sections of the two major highways within the study area, the Sturt Highway and the Balranald-Tooleybuc Road, the current peak hourly traffic volumes (Table 3.2) are all below 120 vehicles per hour. These hourly volumes would correspond to the range of Level of Service A or B (Level of Service A generally).

On the other rural main road within the study area (Balranald–Ivanhoe Road) and most local roads within Balranald town, the peak hourly traffic volumes are all generally below 100 vehicles per hour, which would also correspond to Level of Service A for these roads.

The exception is the section of the Sturt Highway (Market Street) through the main town centre of Balranald which has a higher current peak hourly traffic volume which was surveyed as 284 vehicles per hour on 30 October 2014. This would correspond to Level of Service B generally under the RMS defined level of service standards.

3.4.2 Road widths

For all the major roads assessed, the current traffic situation and the future traffic impacts of the Balranald Project need to be considered in terms of daily traffic volumes. Road width design standards for low volume (generally rural) roads are defined by the Austroads *Guide to Road Design* (Austroads 2010) and are based on daily traffic volumes. The current assessment for these roads is as follows:

- For 0–150 daily vehicles, the Austroads 2010 standard requires single lane sealed, however unsealed dual lane is also generally acceptable, based on other historic standards (eg NAASRA 1984). This is applicable to:
    - Arumpo Road, Burke and Wills Road, Piper Street, O'Connor Street, Moa Street and McCabe Street. Many rural roads in NSW with daily traffic volumes of less than 150 vehicles per day are single lane or two lane unsealed roads which is interpreted as meeting Austroads standards. Usually these roads are only sealed for dust control purposes in proximity to houses, or for traffic safety in the vicinity of bends or intersections.
- For 150–500 daily vehicles, Austroads requires a 6–7 m wide seal (7 m wide if more than 15% heavy vehicles). This is applicable to:
    - Balranald-Ivanhoe Road and Balranald-Toolyebuc Road (southern section). On many rural roads with daily traffic volumes between 150–500 vehicles per day, the road centre line is not normally marked and the road shoulders are not normally sealed.
- For 500–1,000 daily vehicles, Austroads requires a 7–8 m wide seal. This is applicable to:
    - Balranald-Toolyebuc Road (northern section).
- For 1,000–3,000 daily vehicles, Austroads requires a 9 m wide seal. This is applicable to:
    - Sturt Highway rural sections to the east and the west of Balranald.

3.5 Existing road pavement condition

The overall road pavement condition along the majority of the 68 km haulage route length within NSW was observed to be satisfactory with no major surface defect visible along approximately 90% of the total haulage route.

The sealed widths on the existing road network were measured by EMM in October 2014. The existing road pavement condition along the proposed product haulage route was extensively assessed by visual inspections which were undertaken in accordance with best practice Austroads pavement survey guidelines for the haulage route road pavement investigation. The detailed pavement inspection methodology and results are presented in Appendix C.

The existing road pavement condition for the haulage route, based on the visual inspections (Aurecon 2015) is summarised in Table 3.3. The extent of high severity surface deformations such as rutting and corrugations and other surface defects was observed to be more prevalent along the shorter Balranald-Ivanhoe Road, McCabe Street and Sturt Highway sections of the haulage route. On the longer Balranald-Tooleybuc Road section of the route, the observed extent of these defects was much more limited. However, varying degrees of pavement surface bleeding and texture loss were observed along most sections of the route.

The existing Tooleybuc Bridge was observed to have a worn road pavement surface over the timber bridge (Aurecon 2015). The bridge has no load limit other than that applicable to GML vehicles which means all types of vehicles (including B-Doubles) carrying the normal legal axle load limits are permissible but vehicles operating under Higher Mass Limits (HML) increased axle loading permits are not permitted.

The future Aurecon road pavement design loadings and condition assessments for the product haulage route (which are discussed in section 6.5) have been calculated based on the current GML standard axle loadings if vehicles are continuing to use the existing Tooleybuc Bridge, and for the alternative higher HML axle loadings if the vehicles are using an upgraded bridge.

Table 3.3 Existing road pavement condition determined from Aurecon visual inspections

Road section length km and width (m)*	General condition description (June 2014)	Affected by solitary cracking (% area)	Affected by multiple cracking (% area)	Affected by cracking and rutting (% area)	Affected by crocodile cracking (% area)	Affected by surface defor-mation (% area)	Affected by other surface defects (% area)
Balranald-Ivanhoe Road 9.5 km (7 m)*	Intermittent transverse and longitudinal cracking, some rutting along both sides of the road primarily in the eastern lane, significant surface polishing in some areas.	2	6	1	1	2	17
McCabe Street 1.8 km (6.5 m)*	Significant texture loss in some areas accompanied by intermittent transverse and longitudinal cracking, crocodile and meandering cracks.	7	0	0	3	0	58
Sturt Highway 2.8 km (7.5 m)*	Severe block and transverse cracking present on bridges. Persistent longitudinal and transverse cracking present in some areas. Localised crocodile cracking within asphalt surfaces. Consistent bleeding under wheel paths, some minor rutting and shoving.	2	0	0	0.02	1	26

Table 3.3 Existing road pavement condition determined from Aurecon visual inspections

Road section length km and width (m)*	General condition description (June 2014)	Affected by solitary cracking (% area)	Affected by multiple cracking (% area)	Affected by cracking and rutting (% area)	Affected by crocodile cracking (% area)	Affected by surface defor-mation (% area)	Affected by other surface defects (% area)
Balranald-Tooleybuc Road 53.9 km (7 m)*	Persistent rutting and bleeding under wheel paths, accompanied by shoving in some locations. Localised longitudinal, transverse and crocodile cracking within asphalt surfaces. Significant patching of pavement in some areas. Limited sealed shoulder in many areas.	1	0.2	0.1	0.4	2	9

Source: *Aurecon (2015).*

Note: **Road width is the sealed width of the traffic lanes, and excludes the road shoulders where these are sealed.*

Based on the findings of *Haulage Route Pavement Strength Review* (Aurecon 2015) Iluka is negotiating a road safety/ maintenance framework with BSC and RMS to:

- ensure Iluka's commitment improves road safety;
- accommodate design traffic loadings;
- recognise Iluka's potential project induced deterioration on the product haulage route; and
- ensure BSC/ RMS maintain infrastructure to required levels on the product haulage route.

An additional detailed road pavement investigation was also undertaken by Aurecon in June 2014, for the local 1.8 km section of the haulage route which travels via McCabe Street at Balranald, which will assist in determining future road safety/ pavement maintenance for this section of local road.

3.6 Existing road pavement widths

The existing sealed-road pavement widths (including the sealed shoulder width) were measured by EMM during October 2014 along the key study area roads.

The existing road pavement sealed width is generally a minimum of 7.0 m (excluding for McCabe Street and the existing Tooleybuc Bridge which are both relatively short sections). Table 3.4 summaries the measured pavement width on all sections of the product transport haulage route within NSW.

Table 3.4 Road sealed pavement widths measured on the haulage route and other roads

Route	Location	Pavement sealed width* (m)
Balranald- Ivanhoe Road	10 km north of Balranald	7.4*
Balranald- Ivanhoe Road	5 km north of Balranald	6.8*
McCabe Street	South of River Street	6.6*
McCabe Street	South of Island Road	7.0*
Sturt Highway	1 km south of Balranald	9.0*
Sturt Highway	10 km west of Balranald	9.0
Sturt Highway	50 km west of Balranald	9.0
Balranald- Tooleybuc Road	45 km north of Tooleybuc	7.2*
Balranald- Tooleybuc Road	40 km north of Tooleybuc	7.6*
Balranald- Tooleybuc Road	35 km north of Tooleybuc	8.2*
Balranald- Tooleybuc Road	30 km north of Tooleybuc	7.1*
Balranald- Tooleybuc Road	25 km north of Tooleybuc	7.1*
Balranald- Tooleybuc Road	20 km north of Tooleybuc	7.1*
Balranald- Tooleybuc Road	15 km north of Tooleybuc	7.6*
Balranald- Tooleybuc Road	10 km north of Tooleybuc	7.6*
Balranald- Tooleybuc Road	5 km north of Tooleybuc	7.5*
Balranald- Tooleybuc Road	At Tooleybuc Bridge (existing)	3.7 (the road width is limited by the single lane bridge)
Arumpo Road	0–3 km west of Balranald-Ivanhoe Road	6.9
Arumpo Road	3–25 km west of Balranald-Ivanhoe Road	0.0 (two lanes wide unsealed)
Burke and Wills Road	0–22 km north-west of Balranald-Ivanhoe Road	0.0 (two lanes wide unsealed)
Burke and Wills Road	22–46 km north-west of Balranald-Ivanhoe Road	0.0 (single lane wide unsealed)
Balranald- Ivanhoe Road	50 km north of Balranald	6.2
Balranald- Ivanhoe Road	45 km north of Balranald	6.9
Balranald- Ivanhoe Road	40 km north of Balranald	6.3
Balranald- Ivanhoe Road	35 km north of Balranald	5.6
Balranald- Ivanhoe Road	30 km north of Balranald	7.1
Balranald- Ivanhoe Road	25 km north of Balranald	7.3
Balranald- Ivanhoe Road	20 km north of Balranald	7.0
Balranald- Ivanhoe Road	15 km north of Balranald	6.9
Piper Street	North of Sturt Highway	6.0
Moa Street	North of O'Connor Street	5.9
O'Connor Street	West of Moa Street	6.1

Note: **These sections of road are part of the proposed haulage route from the mine to the NSW Victoria border at Tooleybuc.*

From the surveyed current daily traffic volumes in Table 3.1 and the Austroads daily traffic volume standards for rural roads, in Section 3.4, the following roads typically have sealed widths of 7.0 m or more, which meet the Austroads design standard for daily traffic less than 1,000 vehicles, namely:

- Balranald- Ivanhoe Road (MR 67), 5 km north of Sturt Highway;
- Balranald- Ivanhoe Road (MR 67), north of Moa Street;
- Balranald- Tooleybuc Road (MR 694), northern section; and
- Balranald- Tooleybuc Road (MR 694), southern section.

From the surveyed current daily traffic volumes in Table 3.1 and the Austroads daily traffic volume standards for rural roads, in Section 3.4, the following sections of the Sturt Highway, typically have sealed widths of 9.0 m or more, which meet the Austroads design standard for daily traffic volumes between 1,000 and 3,000 vehicles, namely:

- Sturt Highway, 1 km south of Balranald;
- Sturt Highway, east of MR 694 Balranald Tooleybuc Road; and
- Sturt Highway, east of Murray Bridge Road, Euston- Robinvale.

On Balranald-Ivanhoe Road and McCabe Street, the road edge lines are not marked so the EMM measured sealed width excludes the shoulder width. On other sections such as the Sturt Highway and the Mallee Highway, the road edge lines are marked and the EMM measured sealed width includes that part of the shoulder width which is also sealed as well as the sealed traffic lane widths.

On other roads, which are not part of the product haulage route, such as Arumpo Road, Burke and Wills Road, the Balranald-Ivanhoe Road, north of the West Balranald access road intersection, and Piper Street, Moa Street and O'Connor Street within Balranald town, the road sealed widths are generally less than 7.0 m, where these roads are sealed.

However, based on the current daily traffic usage of these roads (Table 3.1), the road sealed widths are adequate for the existing traffic usage.

3.7 Intersection designs

The existing rural and urban intersections on the Balranald Project affected roads have mostly been constructed to appropriate design standards given the traffic operating characteristics of the roads, as illustrated by Photographs 3.1 to 3.15.

Intersection design standards for additional intersection turning lanes are defined by (Austroads 2010). The existing intersection traffic volumes are generally too low to require additional turning lanes at all intersections, except for the two major Sturt Highway intersections which are at the Balranald Tooleybuc Road, south of Balranald, and at Murray Bridge Road (Murray Valley Highway), east of Euston, where additional Type AUL/AUR intersection turning lanes are provided, Photographs 3.7 and 3.8.

Photograph 3.1 **Burke and Wills Road at Arumpo Road intersection (looking north from Burke and Wills Road)**

Photograph 3.2 **Arumpo Road - Balranald-Ivanhoe Road intersection (looking south from Balranald-Ivanhoe Road)**

Photograph 3.3 **Burke and Wills Road - Balranald-Ivanhoe Road intersection (looking north from Balranald-Ivanhoe Road)**

Photograph 3.4 **Balranald-Ivanhoe Road - Moa Street intersection (looking south from Balranald-Ivanhoe Road)**

Photograph 3.5 **Balranald-Ivanhoe Road - McCabe Street intersection (looking south from Balranald-Ivanhoe Road)**

Photograph 3.6 **McCabe Street at Sturt Highway intersection (looking south from McCabe Street)**

Photograph 3.7 **Sturt Highway – Balranald-Tooleybuc Road intersection south of Balranald (looking south from Sturt Highway)**

Photograph 3.8 **Sturt Highway - Murray Valley Highway intersection (Euston- Robinvale) (looking east from Sturt Highway)**

Photograph 3.9 **Balranald-Tooleybuc Road - Kyalite Road intersection (looking south from Balranald-Tooleybuc Road)**

Photograph 3.10 **Balranald-Tooleybuc Road - Swan Hill Road intersection (looking north from Balranald-Tooleybuc Road)**

Photograph 3.11 **Balranald-Tooleybuc Road - Murray Street and Lockhart Street intersection (at Tooleybuc looking north from Murray Street)**

Photograph 3.12 **Murray Street and Tooleybuc Bridge intersection (looking west towards the existing bridge from Murray Street)**

Photograph 3.13 Sturt Highway (Market Street) - Balranald-Ivanhoe Road (Mayall Street) intersection at Balranald (looking west from Mayall Street)

Photograph 3.14 Sturt Highway (Market Street) - Moa Street intersection (looking east from Sturt Highway)

Photograph 3.15 Moa Street - O'Connor Street intersection (looking north from Moa Street)

Summaries of the current design standard and the provision of additional turning lanes at the assessed intersections are provided in Table 3.5. Additional intersection right turn lanes have been constructed to the type AUR/AUL (auxiliary right (AUR) and auxiliary left (AUL) turn treatment) intersection standard for existing traffic volumes and traffic conditions at the two rural Sturt Highway intersections.

At the Sturt Highway urban intersections within Balranald and at the urban intersections within Tooleybuc, additional shoulder lanes are also generally provided (except at Mayall Street for the Sturt Highway traffic travelling eastbound, Photograph 3.13). These additional shoulder lanes can be used as additional turning lanes at the intersection.

For traffic safety reasons, the previous Austroads type AUR/AUL intersection design has now been superseded by either the type CHR (chanellised right turn treatment) or CHR(S) (short lane chanellised right turn treatment) turning lanes which provide a fully protected right turning lane on the major road travelling through the intersection. The implication of this change for the Balranald Project traffic impact assessment is assessed in Section 5.3 and Section 6.3, with reference to the relevant Austroads rural intersection design standards.

Table 3.5 Existing intersections on assessed roads

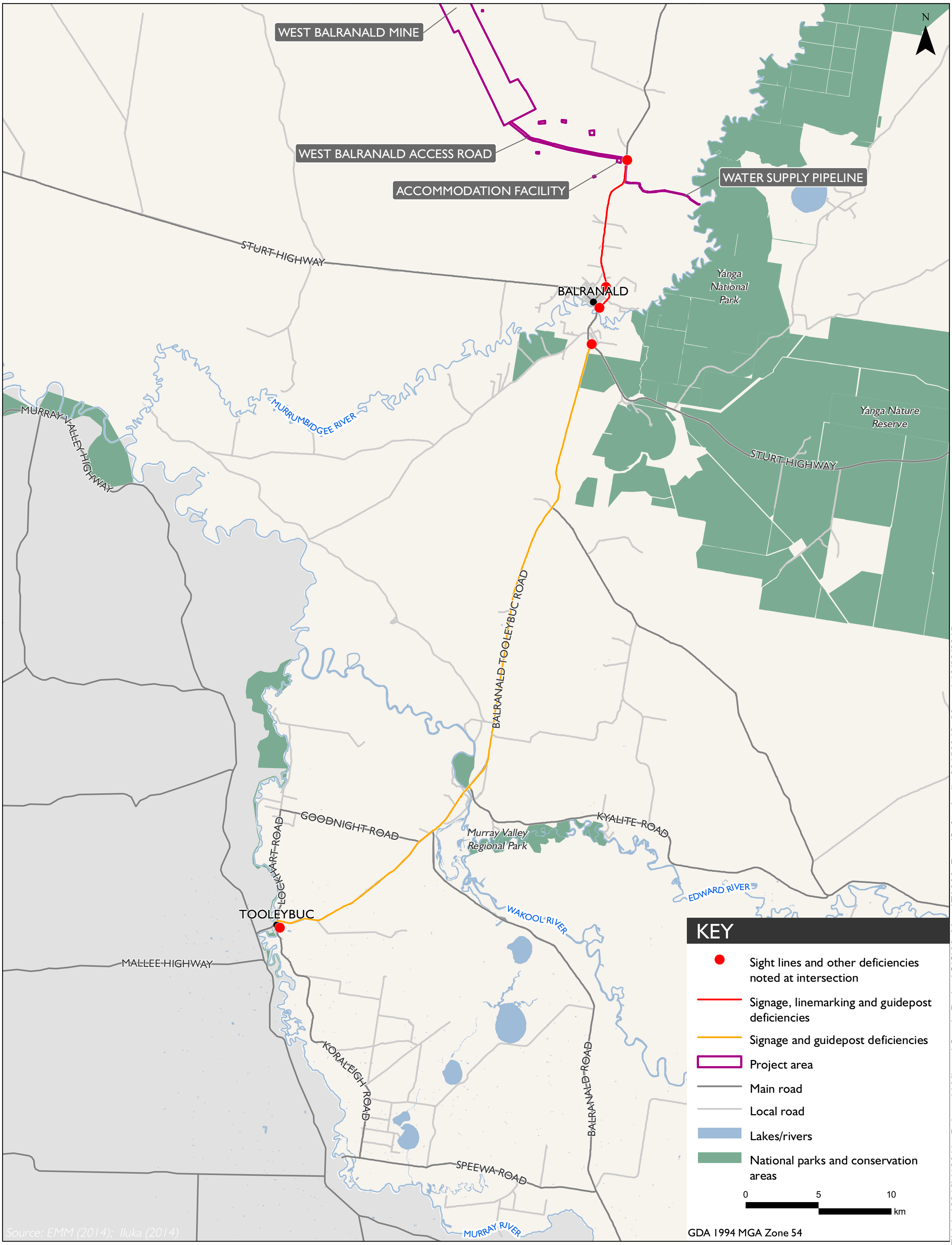
Major road	Minor road	Intersection type	Existing Intersection standard
Arumpo Road	Burke and Wills Road	Rural T intersection	Both roads unsealed
Arumpo Road	Balranald-Ivanhoe Road	Rural T intersection	Both roads sealed with no additional lanes
Burke and Wills Road	Balranald-Ivanhoe Road	Rural T intersection	Both roads sealed with no additional lanes
Balranald-Ivanhoe Road	Moa Street	Rural T intersection	Both roads sealed with no additional lanes
Balranald-Ivanhoe Road	McCabe Street	Rural T intersection	Additional type AUL left turning lane
Sturt Highway	McCabe Street	Urban intersection	Additional shoulder lanes on Sturt Hwy
Sturt Highway	Mallee Highway	Rural T intersection	Additional type AUR/AUL turning lanes
Sturt Highway	Murray Valley Highway	Rural T intersection	Additional type AUR/AUL turning lanes
Balranald Tooleybuc Road	Kyalite Road	Rural T intersection	Both roads sealed with no additional lanes
Balranald Tooleybuc Road	Swan Hill Road	Rural T intersection	Both roads sealed with no additional lanes with additional lanes on the minor road
Balranald Tooleybuc Road	Lockhart Road	Urban T intersection	Additional urban shoulder lanes on Balranald Tooleybuc Road
Tooleybuc Bridge (existing)	Murray Street	Urban T intersection	Additional urban shoulder lanes on the two Murray Street approaches
Sturt Highway	Balranald-Ivanhoe Road	Urban intersection	Additional shoulder lanes on Sturt Hwy with footpath widening on west approach
Sturt Highway	Moa Street	Urban intersection	Additional shoulder lanes on Sturt Hwy
Sturt Highway	Piper Street	Urban T intersection	Additional shoulder lanes on Sturt Hwy
Moa Street	O'Connor Street	Urban T intersection	Both roads sealed with no additional lanes

3.8 Traffic safety

An RSA for the proposed NSW sections of the product haulage route was undertaken by TrafficWorks in November 2012. The full RSA report is included in Appendix D and a map of the locations of the identified deficiencies is presented in Figure 3.3.

The RSA findings and recommendations represent a combination of existing route deficiencies and identified recommendations for consideration in relation to the anticipated Balranald Project traffic usage. An itemised summary of the key recommendations of the RSA for existing traffic conditions and the anticipated future usage of the product haulage route is presented in Table 3.6. These recommendations are further reviewed in relation to the assessed Balranald project construction and operational phase traffic impacts in this report in Section 5.4 and Section 6.4.

Additionally, the RMS accident statistics databases for the past five years for the Balranald and Wakool LGAs, have been reviewed for all rural sections of the product haulage route within NSW, in addition to the rural section of the Sturt Highway west of Balranald (refer Table 3.7).



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NSW road safety audit locations

Balranald Mineral Sands Project

Traffic Assessment

Figure 3.3

Table 3.6 Summary of NSW RSA Recommendations

Route Section	Item	Location	Summary of deficiency	Timing of recommended works	Summary of recommended works
Balranald-Ivanhoe Road	1.1	West Balranald access road intersection location	No street lighting	For the Balranald Project traffic	Installation of lighting at the West Balranald access road intersection
	1.2	West Balranald access road intersection location	Potential for vehicle encroachment when large vehicles are turning into the West Balranald access road	For the Balranald Project traffic	Intersection is to be designed for B Double vehicle access without encroachments
	1.3	West Balranald access road intersection location	Potential for rear end collisions if vehicles do not have sufficient warning of the intersection	For the Balranald Project traffic	The intersection is to be accompanied by advance and position intersection signs
	1.4	Reverse curves 2.0 to 3.5 km south of West Balranald access road	Poor delineation of the curves and guideposts lacking	Existing deficiency	Improvements to the guideposts and pavement edge markings
	1.5	McCabe Street intersection approach	The existing signage is confusing and inappropriate for night time haulage	Existing deficiency	Larger intersection signs are required
McCabe Street	2.1	McCabe Street and Balranald-Ivanhoe Road intersection	Lack of definition of turning lanes and a see through affect between two discontinuous road approaches at the intersection	Existing deficiency also affected by the future Balranald Project traffic	Provide appropriate turn lanes at the intersection, street lighting, signage and the removal of the see through effect at the intersection by additional barriers and landscaping
	2.2	Full 1.8 km length of the route to the Sturt Highway	Poor centre line marking, edge delineation and a lack of guideposts, which are deficiencies for night time usage	Existing deficiency also affected by the future Balranald Project traffic	Provide improved centre and edge line makings, additional warning signs and reflective edge markers
Sturt Highway	3.1	McCabe Street intersection	Sight lines are constrained by signage and vegetation on the southwest and northeast approaches to the intersection	Existing deficiency also affected by the future Balranald Project traffic	Signage location are to be reviewed and vegetation within road reserves removed to meet intersection sight distance requirements
	3.2	Balranald Tooleybuc Road intersection approach	The advance intersection direction signage is located too close to the intersection and on a curve	Existing deficiency	The eastbound advance intersection direction sign should be relocated to 200 from the intersection

Table 3.6 Summary of NSW RSA Recommendations

Route Section	Item	Location	Summary of deficiency	Timing of recommended works	Summary of recommended works
	3.3	Balranald Tooleybuc Road intersection	Safety at the intersection, particularly at night will be improved by a type CHR intersection right turn treatment	Existing deficiency also affected by the future Balranald Project traffic	A Type CHR right turn treatment should be provided at the intersection
Balranald Tooleybuc Road	4.1	Majority of the length of the route	Deficiencies in centre line and edge line markings, lack of curve and bridge warning signs and inadequate guideposts	Existing deficiency	Provision of improved route delineation, guideposts and curve warning signage to AS 1742.2
	4.2	Murray Street intersection and approach to the Murray Bridge	Lack of advance signage for Victoria bound travel. Complex and confusing signage at the entry to the bridge	Existing deficiency also affected by the future Balranald Project traffic	Provision of additional advance route directional signage for Victoria bound traffic and review and removal of unnecessary signage at the entry to the bridge

Since the RSA was undertaken in late 2012 it is noted that RMS have completed delineation and line marking improvements along the Balranald-Tooleybuc Road to address a number of the road safety deficiencies outlined in Table 3.6.

Over the five years, there were a total of 43 reported accidents recorded in the RMS database on the key Balranald Project affected roads outside the Balranald urban area. Three fatal accidents occurred, two on the Sturt Highway on the rural section approximately 40–50 km west of Balranald and one on the Balranald-Tooleybuc Road (Mallee Highway) approximately 10 km north east of Tooleybuc.

The corresponding RMS accident classification maps and accident statistical summary for the roads are summarised in Table 3.7 and the data for each LGA included in Appendix E.

Table 3.7 Summary of accidents on Balranald area major roads

Route	Length	All accidents	Tow- away accidents	Injury accidents	Fatal accidents
Balranald-Ivanhoe Road (from Balranald to the Oxley Road intersection)	25 km	1	0	1	0
Sturt Highway south (outside urban area to Mallee Highway)	2.5 km	2	1	1	0
Sturt Highway west (outside urban area to Murray Valley Highway)	78 km	33	17	14	2

Table 3.7 Summary of accidents on Balranald area major roads

Route	Length	All accidents	Tow- away accidents	Injury accidents	Fatal accidents
Balranald-Tooleybus Road (Mallee Highway) south from Sturt Highway to Tooleybuc	53 km	7	3	3	1
All Routes	**158.5 km**	**43**	**21**	**19**	**3**

Source: RMS Accident History Database 2009 to 2013.

There was only one recorded traffic accident (injury accident) on the Balranald-Ivanhoe Road within 100 km of Balranald during the five year period. This accident occurred approximately 13 km north of Balranald.

However, an additional cluster of five traffic accidents was recorded on the northern most Balranald LGA section of the Balranald-Ivanhoe Road, 0 -25 km south of the boundary with the Central Darling Shire. This road section is over 120 km north of Balranald and is outside the general area of influence of the future workforce or product haulage traffic from the Balranald Project.

Approximately 16% of all the reported traffic accidents within the Balranald LGA (including all traffic accidents within both urban and rural areas) were collisions with fauna, primarily kangaroos. In Wakool LGA, the proportion of all traffic accidents involving collisions with fauna was much lower, being less than 5%.

3.9 Bus, pedestrian and cycling access

Intra and interstate public bus services serve the town of Balranald on a regular basis. CountryLink operates a daily coach service from Cootamundra to Mildura which stops in Balranald in the evening about 9.30 pm. The return service from Mildura to Cootamundra stops in Balranald at 5.40 am.

Long distance bus services between Adelaide and Sydney are provided on weekdays by Greyhound Australia. The westbound services to Adelaide stop in Balranald at 7.00 am and the eastbound services stop in Balranald at about 8.00 pm.

Balranald Community Transport Services (operated by the Far West Health Service) operates two return bus services; on the first Friday of each month from Balranald to Swan Hill and on alternate Wednesdays from Balranald to Mildura.

There are no scheduled air services to or from Balranald Airport which is located just to the north of the town. The airport access road is located on Balranald-Ivanhoe Road, between the McCabe Street and Moa Street intersections.

Due to the distances between the project area and urban areas of Balranald, which are a minimum of 10 km, local pedestrian or cycling access from Balranald town to the project area is considered unlikely.

4 Project description

4.1 Project schedule

The Balranald Project will have a life of approximately 15 years, including construction, mining, backfilling of overburden, rehabilitation and decommissioning.

Construction of the Balranald Project will commence at the West Balranald mine, and is expected to take about 2.5 years. Operations will commence at the West Balranald mine in Year 1, which will overlap with the last six months of construction. The operational phase would include mining and associated ore extraction, processing and transport activities, and would last approximately nine years including the backfilling of overburden at both the West Balranald and Nepean mines. Construction of infrastructure at the Nepean mine will commence in Year 5 approximately, with the mining of ore starting in Year 6, and completion by Year 8 approximately.

Rehabilitation and decommissioning is expected to take a further two to five years following Year 9 of the operational phase.

4.2 Project area

All development for the Balranald Project that is the subject of the SSD application is within the project area as shown on Figure 1.1. The project area is approximately 9,964 ha, and includes the following key project elements, described in subsequent sections:

- West Balranald and Nepean mines;
- West Balranald access road;
- Nepean access road;
- injection borefields;
- gravel extraction;
- water supply pipeline (from the Murrumbidgee River); and
- accommodation facility.

Within the project area, the land directly disturbed for the Balranald Project is referred to as the disturbance area. For some elements of the project, a larger area has been surveyed than would actually be disturbed. This enables some flexibility to account for changes that may occur during detailed design and operation.

4.2.1 West Balranald and Nepean mines

The West Balranald and Nepean mines include:

- open cut mining areas (ie pit/mine void) that would be developed using conventional dry mining methods to extract the ore;
- soil and overburden stockpiles;

- ore stockpiles and mining unit plant (MUP) locations;
- a processing area (at the West Balranald mine), including a mineral processing plant, tailings storage facility (TSF), maintenance areas and workshops, product stockpiles, truck load-out area, administration offices and amenities;
- groundwater management infrastructure, including dewatering, injection and monitoring bores and associated pumps and pipelines;
- surface water management infrastructure;
- services and utilities infrastructure (eg electricity infrastructure);
- haul roads for heavy machinery and service roads for light vehicles; and
- other ancillary equipment and infrastructure.

The location of infrastructure at the West Balranald and Nepean mines would vary over the life of the Balranald Project according to the stage of mining.

4.2.2 Injection borefields

The Balranald Project requires a network of injection borefields in the project area for the return of hypersaline groundwater to the Loxton Parilla Sands aquifer. Within each borefield, infrastructure is generally located in two 50 m wide corridors (approximately 350 m apart) and typically comprises:

- a network of pipelines with a graded windrow on either side;
- access roads for vehicle access during construction and operation;
- rows of injection wells, with wells spaced at approximately 100 m intervals; and
- a series of water storage dams to store water during well development.

4.2.3 Access roads

There are two primary access roads within the project area to provide access to the Balranald Project:

- West Balranald access road – a private access road to be constructed from the Balranald Ivanhoe Road to the West Balranald mine.
- Nepean access road – a route comprising private access roads and existing public roads. A private access road would be constructed from the southern end of the West Balranald mine to the Burke and Wills Road. The middle section of the route would be two public roads, Burke and Wills Road and Arumpo Road. A private access road would be constructed from Arumpo Road to the Nepean mine.

The West Balranald access road would be the primary access point to the project area, and would be used by heavy vehicles transporting HMC and ilmenite. The Nepean access road would primarily be used by heavy vehicles transporting ore mined at the Nepean mine to the processing area at the West Balranald mine.

During the initial construction phase, existing access tracks through the project area from the local road network may also be used temporarily until the West Balranald and Nepean access roads and internal access roads within the project are established.

The construction and operational requirements for these access roads are described further in Section 4.4 and Sections 5 and 6 with road and intersection mitigation measures proposed in Section 7.1.

4.2.4 Accommodation facility

An accommodation facility would be constructed for the Balranald Project workforce. It would operate throughout the construction and operation phases of the project. It would be located adjacent to the West Balranald mine near the intersection of the West Balranald access road with the Balranald Ivanhoe Road.

4.2.5 Water supply pipeline

A water supply pipeline would be constructed to supply water from the Murrumbidgee River for operation of the Balranald Project.

4.2.6 Gravel extraction

Gravel would be required during the construction and operational phases of the Balranald Project. Local sources of gravel (borrow pits) would provide some gravel. During the later stages of the construction phase, gravel would also be sourced externally for the construction of the West Balranald access road, internal haul roads and service roads, and hardstand areas for infrastructure. Processing operations, such as crushing and screening activities (if required) would also be undertaken at the borrow pits.

All gravel for the operational phase would be obtained from external sources, transported to the Balranald Project area via back-loading of the product haulage tracks.

4.3 Balranald Project workforce

The Balranald Project would require a peak workforce of approximately 120 people during the majority of the construction phase, and approximately 550 people during the operational phase. A short period of overlap of the construction and operational stage workforces would require a peak combined construction and operational workforce of 450 people. This peak combined workforce has been assessed as the peak project construction stage workforce in this transport assessment.

It is expected that approximately 70% of the workforce (during both construction and operational phases) would be on site at any point in time. Accordingly, the peak construction and operational workforce on site at any one time is expected to be about 315 and 385 people, respectively.

It is estimated that 80% of the workforce would be drawn from the local region (generally defined as the area within a 200 km radius of the town of Balranald), with 20% coming from outside this region. Peak workforce details are provided in Table 4.1.

Table 4.1 Peak workforce details

Phase	Total	Locally sourced	Non-locally sourced	On-site	On-leave	On site proportion resident at the accommodation facility	On site proportion commuting each day
Construction*	450	360	90	315	135	299	16
Operational phase	550	440	110	385	165	366	19

Notes: ** Peak construction workforce is the peak combined workforce during the overlap of the construction and operational phases.*

1. Peak local workforce sourced from inside a 200 km radius from Balranald town.

2. Peak non-local workforce from outside a 200 km radius from Balranald town.

3. Peak workforce on shift at any point in time.

4. Peak workforce on leave at any point in time.

5. Peak workforce staying at accommodation facility at any point in time.

6. Peak workforce commuting to site at any point in time.

The accommodation facility would provide accommodation for all workers who choose not to commute to the Balranald Project area on a daily basis. It is expected that the vast majority (95%) of the construction (299 people) and operational (366 people) workforces would reside at the accommodation facility and not commute daily. The remaining 5% of each workforce would commute on a daily basis.

The Balranald Project would generate traffic during the construction and operational phases as follows:

- Construction phase:
  - transport of construction phase workforce to and from the project area;
  - transport of construction materials and plant and equipment to the project area;
  - transport of oversized plant from Iluka's WRP mine (Victoria) to the Balranald Project; and
  - transport of gravel from borrow pits and external sources to the project area.
- Operational phase:
  - transport of operational phase workforce (of which a majority would reside at the accommodation facility within the project area);
  - product transport to Iluka's existing rail facility at Hopetoun Victoria (HMC) and to a proposed future rail loading facility at Manangatang, Victoria (Ilmenite);
  - backloading of gravel in vehicles used for product transport from external sources in Victoria;
  - backloading of non-saleable by-products from Iluka's Hamilton Mineral Separation Plant (Hamilton MSP) to the Balranald project area; and
  - general heavy vehicle movements to and from the project area, such as deliveries of mine supplies and consumables and removal of waste, which would occur on a daily basis.

4.4 Project area access

4.4.1 West Balranald access road

Proposed construction access routes for the project are shown in Figure 4.1. The West Balranald access road would be a new two-way access road, approximately 18 km long and 11 m wide. It is proposed to be constructed from the Balranald-Ivanhoe Road to the processing area at the West Balranald mine (refer Figure 4.2).

The West Balranald access road would take approximately four months to construct commencing at the start of the construction phase. Traffic control would be required on Balranald-Ivanhoe Road during construction of the intersection.

The access road would be unsealed with the exception of its intersection with Balranald-Ivanhoe Road. Its design would include shaped shoulders to allow stormwater runoff to drain from the road surface, culverts in low lying areas and reflective road-side markers (eg guideposts).

The proposed intersection of the West Balranald access road and Balranald-Ivanhoe Road would be approximately 11 km north of Balranald (refer Figure 4.2), approximately 450–500 m south of the existing intersection with the Balranald Gypsum mine.

The sight distance visibility to the north and the south of the proposed intersection location is a minimum of 450 m, which is shown by Photographs 4.1 and 4.2. The intersection would be designed and constructed in accordance with the Austroads Road Design Guide (Austroads 2010) and would include the provision of a short auxiliary lane with left turn treatment from Balranald-Ivanhoe Road into the West Balranald access road.

4.4.2 Nepean access road

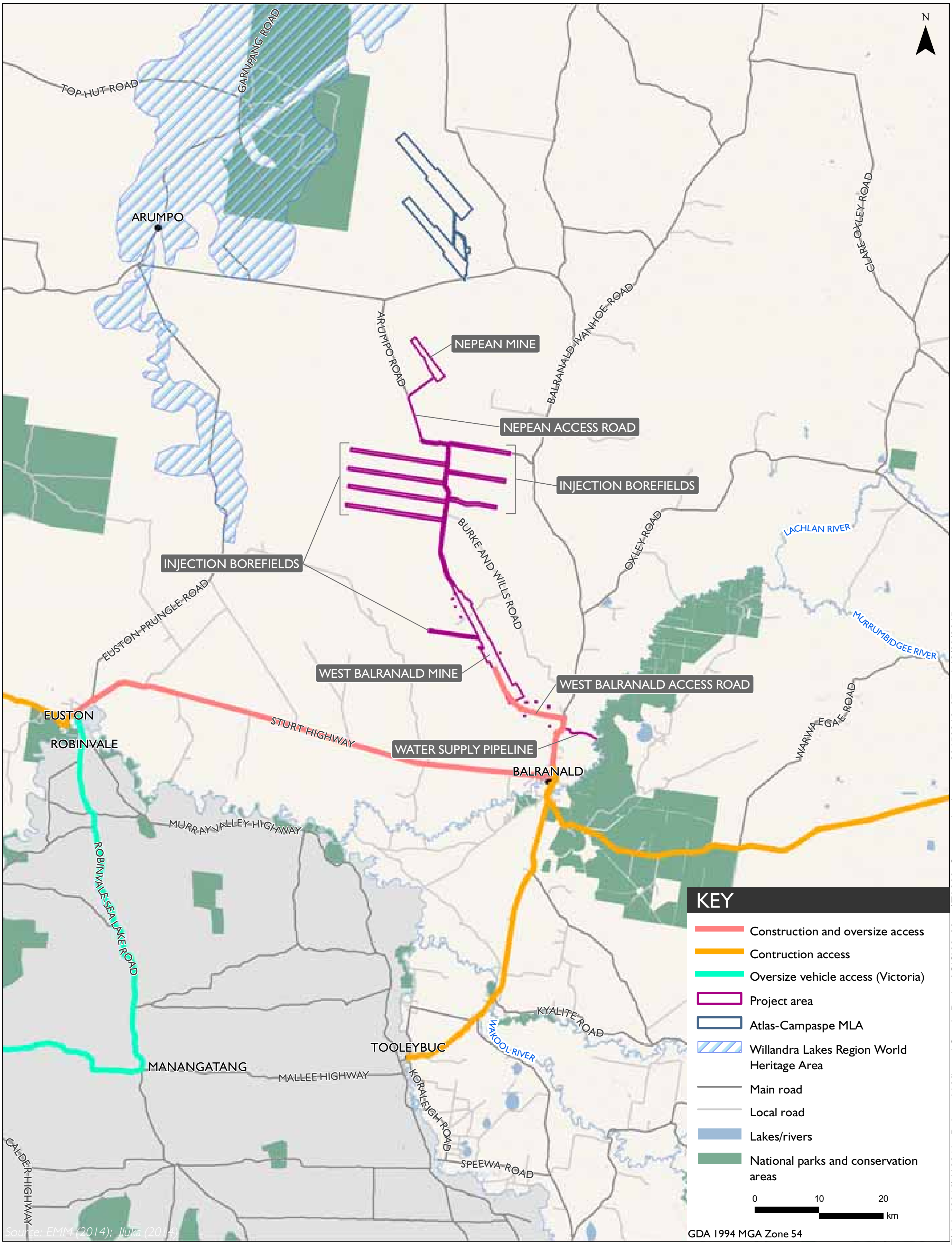
The Nepean access road would be approximately 39 km long comprising new private access roads and sections of two existing public roads (Burke and Wills Road and Arumpo Road) as shown on Figure 4.2.

The Nepean access road would include:

- approximately 22 km of existing public roads via Burke and Wills Road and Arumpo Road;
- a new 12 km section of road constructed from the West Balranald mine north to the Burke and Wills Road; and
- a new 5 km section of road constructed from Arumpo Road to the Nepean mine.

The Nepean access road would provide access between the West Balranald mine and Nepean mine during the life of the Balranald Project. The Nepean access road, from the West Balranald mine to Arumpo Road, is likely to be constructed during the initial construction phase of the Balranald Project to provide access to the injection borefield.

During operations the Nepean access road would be the primary route between the West Balranald and Nepean mines, and would be used to transport extracted ore from the Nepean mine to the processing area at the West Balranald mine. Transport of ore from the Nepean mine is anticipated to occur from approximately Year 6 to Year 8 of the operational phase.

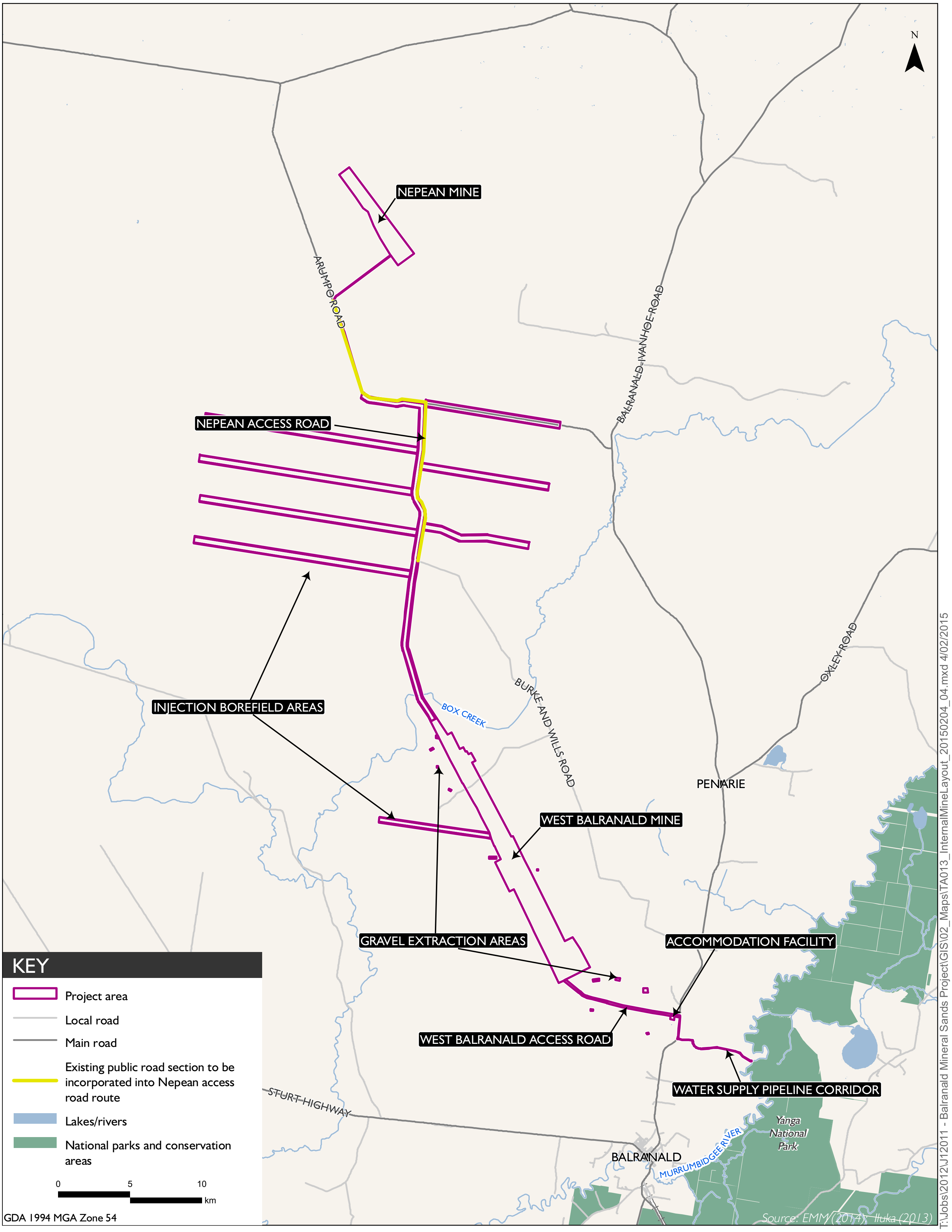


Construction access routes

Balranald Mineral Sands Project

Traffic Assessment

Figure 4.1



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Project area

Balranald Mineral Sands Project
Traffic Assessment

Figure 4.2

As described in Section 3.2, the Burke and Wills Road and Arumpo Roads are generally unsealed except for short sections. The Nepean access road would also be unsealed and upgraded to include shaped shoulders to allow stormwater runoff to drain from the road surface, culverts in low lying areas and reflective road side markers.

Photograph 4.1 Visibility at West Balranald access road intersection location looking north along the Balranald-Ivanhoe Road

Photograph 4.2 Visibility at West Balranald access road intersection location looking south along the Balranald-Ivanhoe Road

4.4.3 Internal roads

Internal roads within the Balranald Project area would be designed and constructed to minimise interaction between heavy vehicles, such as mining equipment and haul trucks, and general light vehicle traffic. Internal roads would be constructed using overburden and gravel. Construction would include vegetation clearing, removal and stockpiling of topsoil and subsoil and civil works.

Car parks would be established at the site office/ processing area at the West Balranald mine and the site office area at the Nepean mine.

During the early construction phase, the Balranald Project area would also be accessed via existing formed tracks off Burke and Wills Road prior to completion of construction of the West Balranald access road and other internal roads within the Balranald Project area.

4.5 Traffic generation

4.5.1 Construction phase traffic generation

Construction of the West Balranald mine is expected to take 2.5 years. Construction would involve all non-mining related activities required to establish the base infrastructure on site, and would include:

- establishment of construction compound, including bulk earthworks;
- gravel extraction from borrow pits;
- construction of West Balranald and Nepean (portion) access roads;
- construction of buildings, workshops, security fencing, and other ancillary facilities;
- installation of groundwater management (extraction and injection) infrastructure;
- establishment and commissioning of the processing plant;
- construction of the accommodation facility; and
- construction of the water supply pipeline.

Construction at the Nepean mine would commence in the later stages of mining at the West Balranald mine, in approximately Year 5.

The primary construction access routes for the Balranald Project are shown in Figure 4.1. These include the regional heavy vehicle haulage routes via the Sturt Highway, Balranald-Ivanhoe Road and Balranald-Tooleybuc Road, as well as temporary construction access along the Burke and Wills Road and Arumpo Road in the vicinity of the Balranald Project area. Oversize vehicle access would generally be along the Sturt Highway via Robinvale/Euston, west of Balranald.

The primary access to the Balranald Project area for construction traffic would would be via the West Balranald access road. As identified in Section 4.2.3 and Section 4.4.2, the project area would also be accessed via existing formed private access tracks off Burke and Wills Road prior to the construction of the West Balranald access road and other internal roads.

i Workforce

The majority of the peak construction workforce (299 persons – refer to Table 4.1) would reside at the accommodation facility within the Balranald Project area. These workers would travel by shuttle bus each day from the accommodation facility to various locations within the project area. This would require some use of local roads while the West Balranald access road and internal road network are being constructed.

Approximately 20 shuttle bus movements (10 trips each way) per day would be generated, based on an average capacity of 30 people per bus. The normal daily shuttle bus movements have been assumed to be distributed as follows:

- seven buses to/from the West Balranald mine site (209 workers); and
- three buses to/from other areas including gravel extraction areas, groundwater injection borefields and water supply pipeline construction areas (90 workers).

The remaining 16 peak construction workers would generally commute by car each day. It has been conservatively assumed that with a maximum 1:1 workforce/ car driver ratio, there would be 32 light vehicle movements each day from the Balranald area, Hay, Swan Hill, Euston or Robinvale. The distribution of this light vehicle traffic has been determined based on the likely residential locations of the locally based construction workforce, with approximately:

- 80% travelling to and from the Balranald town;
- 10% travelling to and from the west, ie Euston and/or Robinvale; and
- 10% travelling to and from the south and east, ie Swan Hill and Hay.

It is also estimated that there would be approximately 40 daily light vehicle movements for an estimated 20 locally based staff working at the accommodation facility.

For the Drive-in-Drive-out (DIDO) and Fly-in-Fly-Out (FIFO) car or bus travel movements for the construction employees coming on or off shift it is assumed that 45 employees (approximately 14%) of the construction workforce on average each day (80% of whom would be DIDO and 20% would be FIFO) would travel both to and from the accommodation facility.

Approximately 36 DIDO employees would come on and off shift each day (with approximately 1.2 persons per car) generating about 30 light vehicle trips each way travelling to and from the accommodation facility each day on the following routes:

- 70% to and from the west, ie Mildura, Euston and Robinvale;
- 15% to and from the east, ie Hay or other towns to the east; and
- 15% to and from the south, ie Swan Hill or other towns in that direction.

The remaining nine FIFO employees coming on and off shift each day would typically generate one bus movement each day travelling both to and from the nearest regional airport at Mildura.

This TA has assumed that the peak workforce traffic movements generated at shift changeover times during both the construction and operational phases would coincide with the existing morning and afternoon peak traffic periods on the surrounding road network. It has also been assumed that 50% of the total daily workforce traffic movements would occur during existing peak periods at affected intersections.

The daily traffic movements which are summarised in Figure 4.3, correspond to the peak stage of the project construction in 2018 when a workforce of 299 persons would based on-site at the workforce accommodation village. By this stage, the West Balranald access road would have been completed and would carry the majority of the project construction workforce traffic, shuttle bus movements and truck deliveries. However, during earlier stages of project construction, before these facilities are completed, the maximum daily project construction traffic movements which would be using existing unsealed sections of Burke and Wills Road would be a maximum of 50 vehicles each day (100 daily vehicle movements), including all light vehicle traffic and truck deliveries.

ii Delivery trucks

Heavy vehicle movement generated during project construction on a daily basis would include:

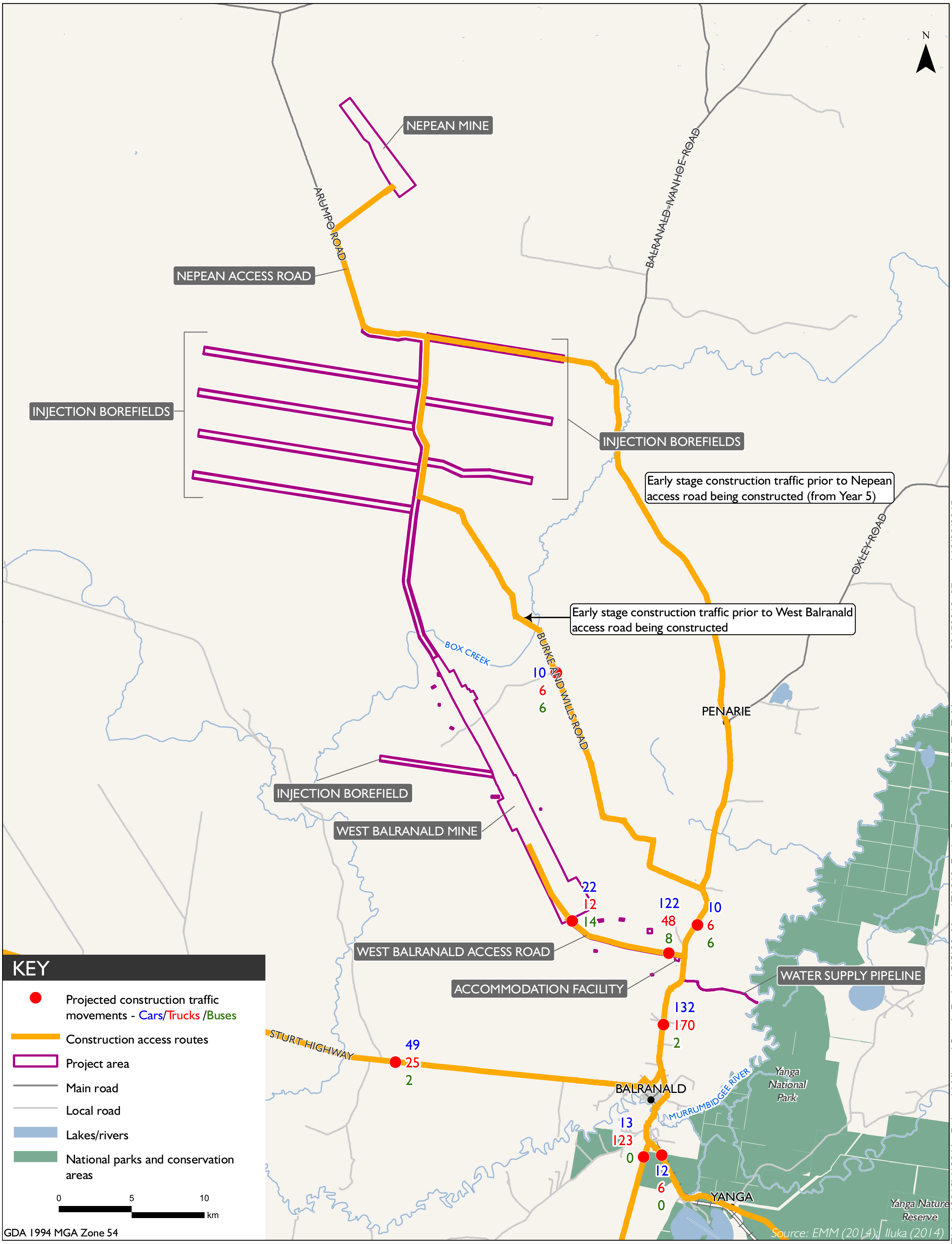
- 18 truck deliveries (36 movements) for potable water supply, waste water transport, miscellaneous deliveries and waste removal, primarily from the accommodation facility, of which 16 movements are assumed to be to and from Balranald town and 20 movements to and from other regional destinations;
- 7 truck deliveries (14 movements) for miscellaneous deliveries including equipment, sand, soil, gravel, pipes, steelwork, concrete, mechanical and electrical components and pre-manufactured items, assumed to be equally distributed to/from the west (from the Euston and Mildura direction) and to/from the south and east (from the Swan Hill and Hay directions); and
- up to 58 truck deliveries per day (116 movements) during the final two years of Balranald Project construction from external gravel suppliers, primarily within Victoria. These truck traffic movements would travel via the existing Tooleybuc Bridge and Balranald-Tooleybuc Road route to Balranald from Victoria.

Over dimensional ('oversize') vehicles would be used to move large plant and equipment from Iluka's WRP mine near Ouyen, Victoria, to the Balranald Project. The over dimensional route has been determined by the constraints of the existing road network, including road width and weight restrictions of bridges across the Murray River from Victoria to NSW (Aurecon 2012).

It is anticipated that over dimensional vehicles would enter NSW from Robinvale, Victoria, and would access the Balranald Project using the following roads:

- Sturt Highway from Robinvale/Euston;
- Piper Street;
- O'Connor Street;
- Moa Street; and
- Balranald-Ivanhoe Road.

There would be approximately four over dimensional vehicle movements per day from WRP mine to the Balranald Project over approximately five months during the construction phase.



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Proposed construction daily traffic movements

Balranald Mineral Sands Project

Traffic Assessment

Figure 4.3

4.5.2 Operational phase traffic generation

i Workforce

The peak workforce during the operational phase would be approximately 385 persons on site at any point in time. Typically, 366 persons would reside at the accommodation facility and 19 would commute on a daily basis (see Table 4.1). The daily traffic movements generated by this peak workforce are summarised in Figure 4.4. During Year 5, construction work at the Nepean mine may result in a proportion of this traffic travelling via Balranald-Ivanhoe Road and Arumpo Road to access the Nepean mine for a short period.

The majority of the workforce residing at the accommodation facility would generally travel by bus within the project area on a daily basis. Assuming an average utilised capacity of 30 people per bus, approximately 24 movements per day would be required to transport this workforce, as follows:

- 8 buses to/from the West Balranald mine (244 persons) – these traffic movements would be within the project area (not on the local road network); and
- 4 buses to/from other parts of the project area (122 persons) – these traffic movements would be on the local road network (primarily Balranald-Ivanhoe Road).

The remaining 19 people would commute by car each day to the Balranald Project area. Assuming a single person per vehicle, this would generate 38 vehicle movements travelling either to or from the Balranald, Hay, Swan Hill, Euston or Robinvale areas. The distribution of this light vehicle traffic has been determined based on the likely residential locations of the locally-based operational workforce, which is approximately:

- 80% travelling to and from the Balranald town;
- 10% travelling to and from the west, eg Euston and Robinvale/or; and
- 10% travelling to and from the south and east, eg Swan Hill and/or Hay.

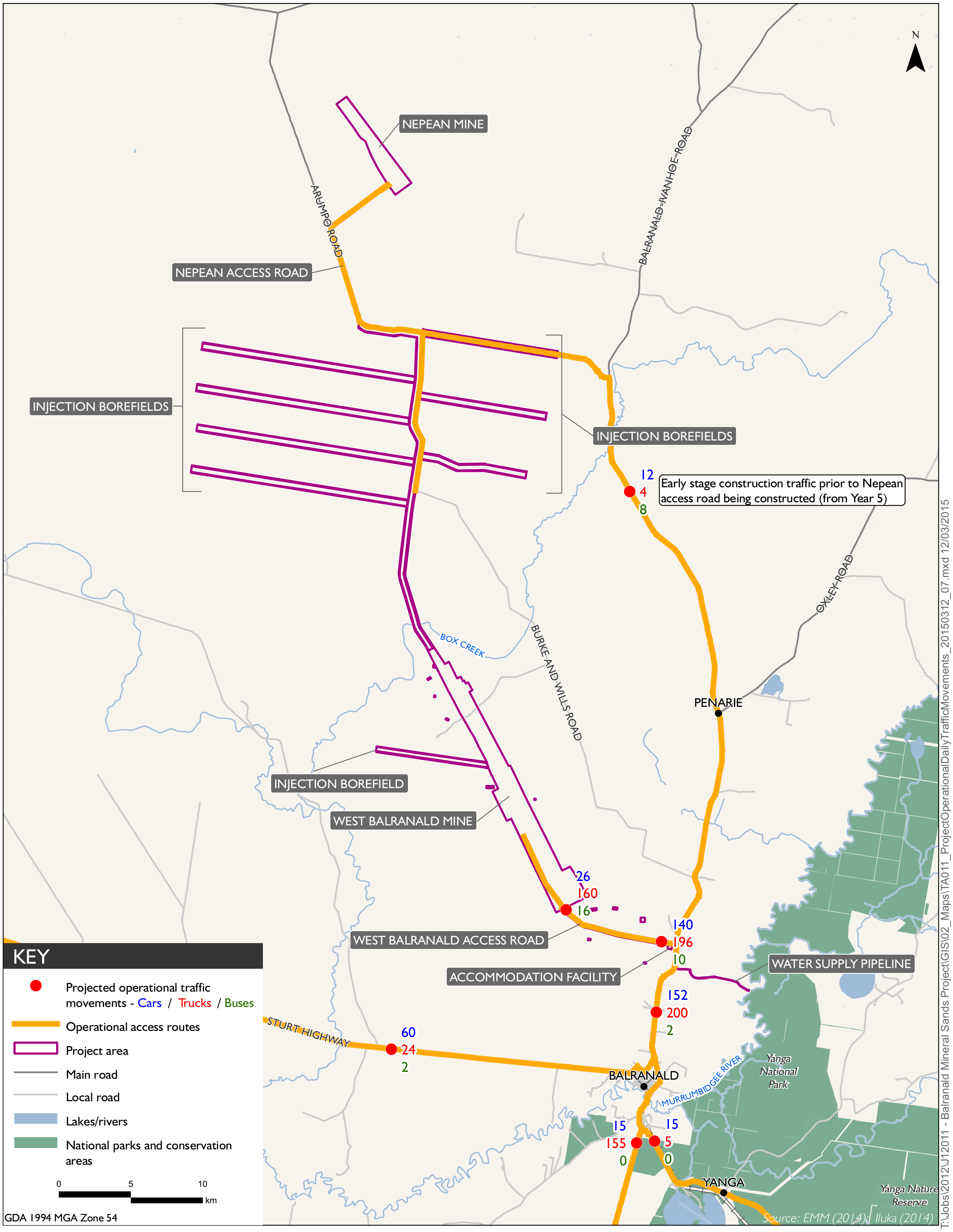
Additional light vehicle traffic travelling to and from the accommodation facility has been estimated at 40 movements daily for locally based staff working at the accommodation facility.

Additional DIDO or FIFO workforce car or bus travel arrangements for the employees coming either on or off shift each day, have been assessed for 55 employees travelling each way per day. A split of 80% DIDO and 20% FIFO travel has been assumed (ie 44 DIDO and 11 FIFO).

The 44 DIDO employees coming on and off shift each day (with 1.2 persons per car) would generate 37 daily light vehicle trips each way per day travelling to and from the following directions:

- 70% to and from the west, ie Mildura, Euston and Robinvale;
- 15% to and from the east, ie Hay or other towns to the east; and
- 15% to and from the south, ie Swan Hill or other towns in that direction.

The remaining 11 FIFO employees would typically generate one bus movement each way per day, travelling to and from the airport at Mildura.



Project operational daily traffic movements

Balranald Mineral Sands Project

Traffic Assessment

Figure 4.4

ii Delivery trucks and oversize vehicle traffic

Heavy vehicle traffic would be generated during the operational phase daily deliveries of mine supplies, consumables, waste removal and other miscellaneous deliveries. The normal daily truck traffic generation is summarised in Table 4.2.

Table 4.2 Daily truck movements for bulk commodities

Type of delivery	Daily trips (vehicle movements)
Hydrated lime	1 (2)
Diesel	3 (6)
Limestone	3 (6)
Potable water supply and waste water transport	8 (16)
Miscellaneous deliveries and waste removal	10 (20)
Gravel	Included as backloaded with product haulage
Total trips per day (vehicle movements)	25 (50)

It has been assumed that 16 movements per day would be generated to and from Balranald town. The remainder would be to and from other regional destinations.

iii Product haulage

The Balranald Project would generate two mineral product streams:

- HMC – up to 500,000 tonnes per annum (tpa); and
- Ilmenite – up to 600,000 tpa.

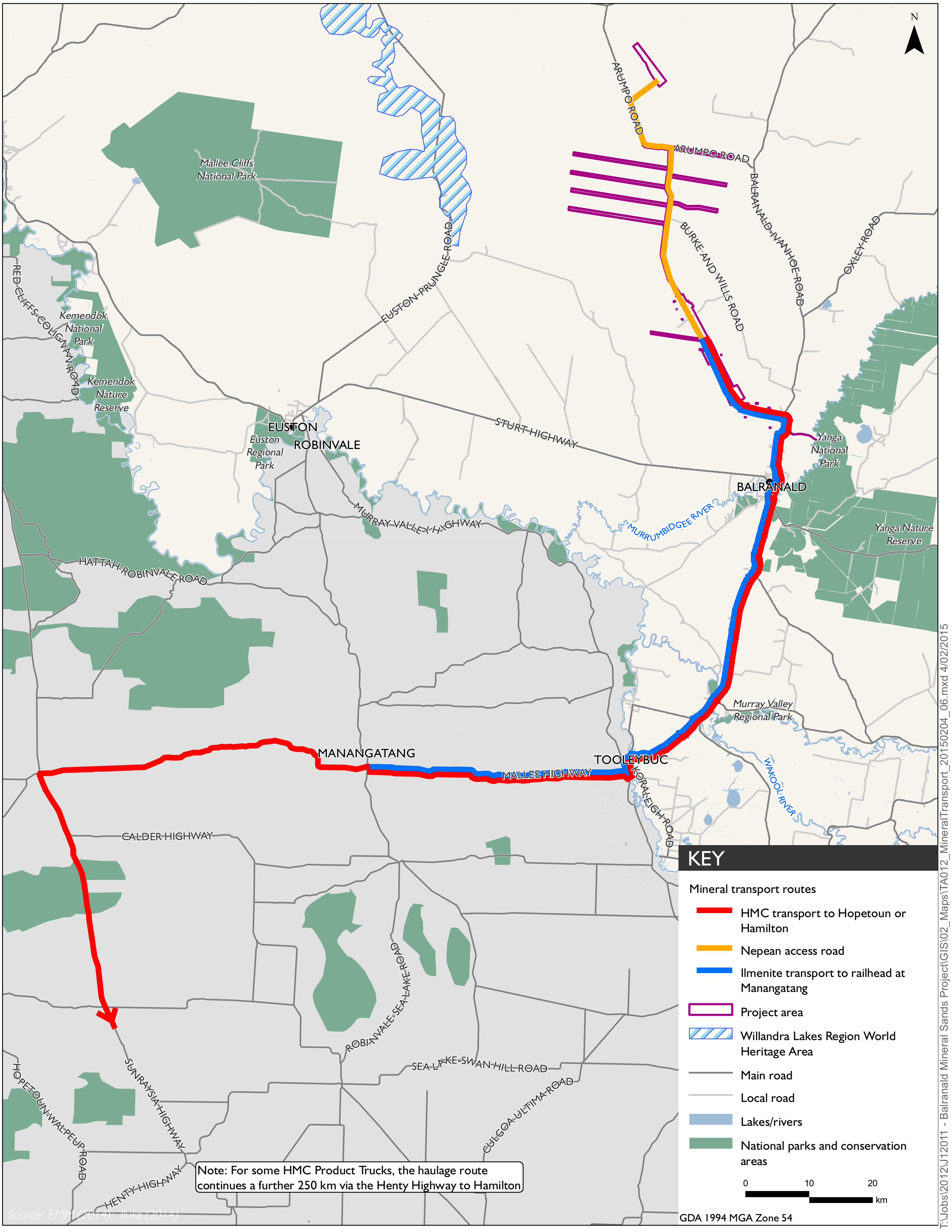
The HMC produced would be trucked to Iluka's existing rail loading facility in Hopetoun, Victoria where the HMC would be transferred to rail for the remaining journey to the Hamilton MSP. A portion of the HMC produced, corresponding to the volume of mining by-products to be backloaded from the Hamilton MSP to Balranald, would be trucked all the way to the Hamilton MSP. These trucks would be backloaded with MSP by-products, which would be returned to the project area for placement within the mine void. Ilmenite would be transported to a proposed future rail loading facility at Manangatang, Victoria.

The proposed mineral transport routes to be used for the product haulage are shown in Figure 4.5. The potential maximum daily and annual vehicle movements generated are summarised in Table 4.3.

Table 4.3 Product transport for maximum product transport scenario

Details	HMC	Ilmenite
Annual tonnage (t)	500,000	600,000
Trucking distance – one way	To Hopetoun – 270 km To Hamilton MSP – 520 km	To Manangatang – 125 km
Trips per annum	12,500	15,000
Trips per day (movements)[1]	35 (70)	40 (80)

Notes: 1. Assumes haulage on 365 days per year.



EMM ILUKA

Proposed mineral transport routes

Balranald Mineral Sands Project

Traffic Assessment

Figure 4.5

HMC and ilmenite would be transported via Balranald-Ivanhoe Road, McCabe Street, Sturt Highway, Balranald-Tooleybuc Road and then west into Victoria. The roads within NSW that are proposed to be used are described in detail in Section 3.2.

Transport of ilmenite would be either by B-double tipper trucks (in bulk) or containerised on flat-bed trucks. Ilmenite would be transported to a proposed future rail loading facility in Manangatang, Victoria. The haulage route operations are described further in Section 6.1.

A maximum of 75 B-Double trucks transporting HMC and ilmenite would be generated daily. Of these, approximately 71 trucks would return each day back-loaded with either gravel (58 trucks per day) or mining by-products from the Hamilton MSP (13 trucks per day).

As discussed in *Haulage Route Pavement Strength Review* (Aurecon 2015), for the maximum of 150 B-Double truck movements generated each day from the product haulage and back-loading of gravel and/or mining by-products. four potential product haulage scenarios have been analysed. These assess the product haulage route pavement impacts assessment including the maximum and lower product transport scenarios, namely:

- Scenario 1, transport of HMC only using GML trucks, 35 trucks per day each way, representing 70 daily truck movements;
- Scenario 2, transport of HMC and ilmenite using GML trucks, 75 trucks per day each way, representing 150 daily truck movements;
- Scenario 3, transport of HMC only using HML trucks, 31 trucks per day each way, representing 62 daily truck movements; and
- Scenario 4, transport of HMC and ilmenite using HML trucks, 68 trucks per day each way, representing 136 daily truck movements.

As described in Section 1.6, this transport assessment has considered the impacts of the proposed project haulage on road traffic and intersections based on the maximum truck numbers (Scenario 2). However, the impacts on the project haulage route pavement condition (and the future road maintenance requirement) have been considered for all four haulage scenarios during the project operational phase.

iv Transport of ore from Nepean mine

The transport of ore from the Nepean mine to the processing area at the West Balranald mine would occur via the Nepean access road, using B-triple road train trucks. This would occur from Year 6 to Year 8 of the operational phase.

This transport of ore from the Nepean mine would generate approximately one truck every six minutes travelling in each direction, approximately 500 daily truck movements in total, on the Nepean access road over the three year period of mining at the Nepean mine.

5 Construction phase impacts

5.1 Traffic generation

Traffic generation during the construction phase of the Balranald Project is described in Section 4.5.1. To assess traffic impacts, background traffic has been assumed to have a linear growth rate of 2.5% per annum. Predicted construction phase traffic from the Atlas-Campaspe Mineral Sands Project (from GTA (2012)) has also been included, as it would also potentially contribute to higher traffic levels on the road network assessed.

For the purposes of the TA report, it is assumed that the peak construction phase would occur in 2018. The predicted changes to base traffic volumes (ie without the Balranald Project) in 2018 are presented in Table 5.1. The daily traffic volumes surveyed in 2014 would have increased by approximately 10% by 2018 (assuming a 2.5% annual growth rate) and daily traffic volumes surveyed in 2006 would have increased by approximately 30%.

Table 5.1 Adjustments to existing daily traffic volumes (2018)

Road name	Locality traffic growth	Locality traffic growth	Atlas-Campaspe project traffic	Atlas-Campaspe project traffic	Average daily traffic	Average daily traffic
Vehicle type	**All traffic**	**Heavy vehicles**	**All traffic**	**Heavy vehicles**	**All traffic**	**Heavy vehicles**
Balranald-Ivanhoe Road-Ivanhoe Road (north of Oxley Road)	65	16	114	8	179	24
Balranald-Ivanhoe Road (5 km north of Sturt Highway)	337	84	114	8	451	92
Balranald-Ivanhoe Road (north of Moa Street)	460	109	114	8	574	117
Mayall Street (north of Market Street)	781	78	58	6	839	84
McCabe Street (southern end)	151	62	4	2	155	64
Sturt Highway (1 km south of Balranald)	1,624	546	4	2	1,628	548
Sturt Highway (east of MR 67 Balranald-Tooleybuc Rd)	1,260	441	4	2	1,264	443
Sturt Highway (Euston, east of Murray Bridge Road)	1,580	553	54	0	1,634	553
Balranald-Tooleybuc Road (northern section)	615	149	0	0	615	149
Balranald-Tooleybuc Road (southern section)	424	101	0	0	424	101
Balranald-Tooleybuc Road (at existing Tooleybuc Bridge)	1,090	198	0	0	1,090	198
Arumpo Road (western section)	33	3	0	0	33	3
Arumpo Road (eastern section)	22	2	0	0	22	2
Burke and Wills Road (northern end)	11	1	0	0	11	1
Burke and Wills Road (southern end)	22	2	0	0	22	2

Table 5.1 Adjustments to existing daily traffic volumes (2018)

Road name	Locality traffic growth	Locality traffic growth	Atlas-Campaspe project traffic	Atlas-Campaspe project traffic	Average daily traffic	Average daily traffic
Piper Street (at Sturt Highway)	77	8	0	0	77	8
Moa Street (at Sturt Highway	396	20	54	0	450	20
Moa Street (north of O'Connor Street)	110	11	54	0	165	11
O'Connor Street (west of Moa Street)	132	13	0	0	132	13
Market Street Sturt Highway (west of Mayall Street)	3,250	600	0	0	3,250	600

It has conservatively been assumed that approximately half the predicted traffic from the Atlas-Campaspe Mineral Sands Project travelling to and from the Mildura area (54 vehicle movements daily) would use the direct route via Wampo, and the remaining half would travel via Balranald using the Balranald-Ivanhoe Road and Sturt Highway route (54 vehicle movements daily).

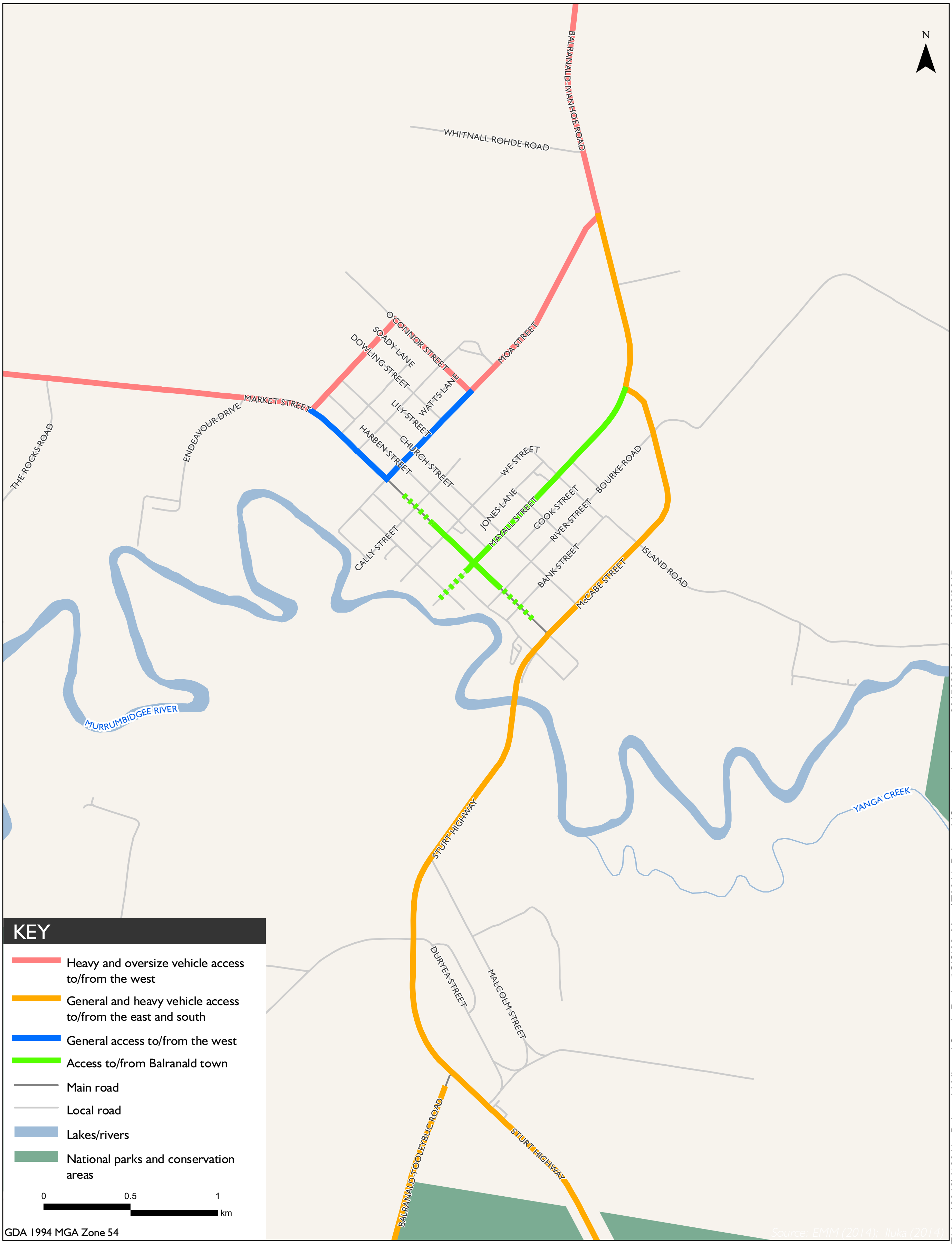
5.2 Road carriageway impacts

The predicted traffic volume increases during the peak construction phase (2018), are summarised in Table 5.2. Proposed construction traffic routes to be used in the vicinity of the project area are shown in detail in Figure 5.1.

Table 5.2 Assessed Balranald Project daily construction traffic increases for each route in 2018

Road name	Average daily traffic		Project daily traffic		Total daily traffic		Traffic increase (%)	
Vehicle type	All traffic	Heavy vehicles	All traffic	Heavy vehicles[1]	All traffic	Heavy vehicles	All traffic	Heavy vehicles
Balranald-Ivanhoe Road (north of Oxley Road)	179	24	0	0	179	24	0	0
Balranald-Ivanhoe Road (5 km north of Sturt Highway)	451	92	304	172	755	264	67	187
Balranald-Ivanhoe Road (north of Moa Street)	574	117	304	172	878	289	53	147
Mayall Street (north of Market Street)	839	84	74	16	913	100	9	19
McCabe Street (southern end)	155	64	154	129	309	193	99	201
Sturt Highway (1 km south of Balranald)	1,628	548	154	129	1,782	677	9	24
Sturt Highway (east of MR 67 Balranald-Tooleybuc Rd)	1,264	443	18	6	1,282	449	1	1
Sturt Highway (Euston, east of Murray Bridge Road)	1,634	553	76	27	1,710	580	5	5
Balranald-Tooleybuc Road (northern section)	615	149	136	123	751	272	22	83
Balranald-Tooleybuc Road (southern section)	424	101	136	123	560	224	32	122
Balranald-Tooleybuc Road (existing Tooleybuc Bridge)	1,090	198	136	123	1,226	321	12	62
Arumpo Road (western section)	33	3	0	0	33	3	0	0
Arumpo Road (eastern section)	22	2	0	0	22	2	0	0
Burke and Wills Road (northern end)	11	1	22	12	33	13	200	1200
Burke and Wills Road (southern end)	22	2	22	12	44	14	100	600
Piper Street (at Sturt Highway)	77	8	25	25*	102	33	32	313*
Moa Street (at Sturt Highway	450	20	51	2*	501	22	11	10*
Moa Street (north of O'Connor Street)	165	11	76	27*	241	38	46	245*
O'Connor Street (west of Moa Street)	132	13	25	25*	157	38	19	192*
Market Street Sturt Highway (west of Mayall Street)	3,250	600	24	6	3,274	606	1	1

*Notes: *as a mitigation measure Iluka would seek to redirect the majority of heavy vehicles travelling from Mildura to use the McCabe Street bypass to minimise impacts to these residential areas.*



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Balranald town construction access routes

Balranald Mineral Sands Project

Traffic Assessment

Figure 5.1

5.2.1 Project area access

As described in Section 4.4, primary construction access routes for the Balranald Project would include the Sturt Highway, Balranald-Ivanhoe Road and Balranald – Tooleybuc Road. Burke and Wills Road and Arumpo Road would be used for occasional access during West Balranald and Nepean construction phases.

There would generally be no Balranald Project traffic usage of Arumpo Road during the West Balranald peak construction phase, as construction work for the Nepean mine deposit would not commence until approximately Year 5.

During the peak stage of project construction, which is represented by the additional project generated traffic volumes and the assessment which presented in Figure 4.3 and Table 5.2, the maximum project generated volumes along Burke and Wills Road would be approximately 22 daily vehicle movements (car/light vehicle, delivery trucks and bus movements) using this route to access project area worksites.

However, during the early stages of the project construction, prior to the construction of the West Balranald access road and project accommodation village, the maximum daily project daily construction traffic movements using existing unsealed sections of Burke and Wills Road may be greater and would be a maximum of 50 vehicles each day (100 daily vehicle movements), including all light vehicle traffic and truck deliveries.

With, the additional construction traffic using Burke and Wills Road on the southern section of this road (refer Table 5.2) the combined total traffic movements would increase to 33 – 44 daily vehicle movements (or 111 – 122 daily vehicle movements during early stage construction prior to the completion of the West Balranald access road). For these traffic volumes a minimum two lanes (ie 8 m) unsealed road would be maintained for this route during the construction access period. Road sections would be regraded during the construction phase to minimise corrugations, potholes and other surface defects.

The upgrade to the northern section of this road (north of where it connects to the West Balranald access road) would not be required until the commencement of construction of the Nepean mine (approximately Year 5) as this section would not be used by significant Balranald Project traffic until this time.

5.2.2 Balranald-Ivanhoe Road

Along sections of the Balranald-Ivanhoe Road outside the Balranald urban area, (ie between Moa Street and the West Balranald access road intersection), the maximum project construction traffic usage would be approximately 304 daily vehicle movements, consisting of car/light vehicle and delivery truck movements.

It is assumed that there would be minimal construction workforce or truck traffic travelling to or from the Ivanhoe direction north of Burke and Wills Road.

Construction traffic on Balranald-Ivanhoe Road would result in up to a 53–67% increase to the future 2018 daily general traffic and up to 147–187% increases in heavy vehicle traffic usage of the road for the duration of the construction phase. The combined future traffic usage in 2018 would be in the range 755–878 vehicle movements daily. This would be below the level where widening of the existing 7 m sealed road width would be required to meet Austroads road design standards (being approximately 1,000 vehicle movements daily).

On the sections of Balranald-Ivanhoe Road closer to the town centre (Mayall Street), the maximum Balranald Project construction traffic usage would be approximately 74 daily vehicle movements, after the dispersion of significant proportions of traffic onto other routes (eg McCabe Street, Moa Street, O'Connor Street and Piper Street). The traffic volume increases from the project construction traffic on Mayall Street would be approximately 9% (all traffic) and 19% (heavy vehicles) in 2018. These traffic increases would not require any road or intersection improvements.

The future intersection capacity of the Mayall Street and Market Street (Sturt Highway) intersection has been assessed using SIDRA (see Section 5.3.2).

5.2.3 Balranald town roads

Traffic volumes are predicted to increase on some roads through Balranald town (refer Table 5.2), including McCabe Street, Moa Street, Piper Street, O'Connor Street and Market Street (the Sturt Highway).

Traffic is predicted to increase by 1% on Market Street, which would not be noticeable for either general or heavy vehicle traffic.

On McCabe Street, the predicted daily traffic increases would be approximately 99% for general traffic and 201% for heavy vehicle traffic. McCabe Street is currently an eastern heavy vehicle bypass route around the town of Balranald. In the absence of traffic from the Balranald Project, the daily traffic is predicted to be greater than 150 vehicle movements per day by 2018. At this traffic volume the road sealed width should be increased to 7 m to meet Austroads road design standards. Traffic from the Balranald Project would further increase this traffic to approximately 309 vehicle movements daily which (in combination with the significant anticipated heavy vehicle traffic usage) would warrant an increase in the road sealed width to 7 m to meet Austroads design standards.

On Piper Street and O'Connor Street, the proportional daily traffic increases would be approximately 19% to 32% for general traffic, and potentially higher for heavy vehicle traffic. The future total daily traffic volumes would be between 102-157 vehicle movements, which would not require increases to the existing road sealed widths generally. However, at some locations additional intersection earthworks (unsealed widening with fill) would be required to accommodate swept paths for oversize vehicle movements see Section 5.3.2.

On Moa Street north of O'Connor Street, the predicted daily traffic increases would be approximately 46% for general traffic and potentially up to 245% for heavy vehicle traffic during the peak construction phase. In the absence of traffic from the Balranald Project the predicted daily traffic by 2018 (165 vehicle movements) would exceed the Austroads road design standards, requiring the road sealed width to be increased to 7 m (over 150 vehicle movements per day). Traffic from the Balranald Project construction (potentially up to 76 vehicle movements daily) would have no additional effect.

On Moa street south of O Connor Street, the project construction daily traffic increases would be approximately 11% and would be limited to light vehicles only. This additional traffic would not be expected to have any noticeable traffic effect on this section as the existing traffic volumes and the sealed width for the sections of Moa Street near the Sturt Highway are wider than further to the north, and the proportional project generated daily traffic increases would not generally be noticeable on these sections.

With the exception of the project construction stage oversize vehicle movements which would need to travel via Piper Street, O'Connor Street and Moa Street, Iluka would seek to direct the other project construction stage heavy vehicle traffic which is travelling to and from the west of Balranald (from the Robinvale or Mildura directions) to travel via McCabe Street and the Sturt Highway (Market Street) when travelling through Balranald. This would minimise the potential traffic impacts to residential areas.

5.2.4 Sturt Highway and Balranald-Tooleybuc Road

Balranald Project construction traffic would increase traffic volumes on the Sturt Highway, east and west of Balranald by 1–5% for general traffic and 1–5% for heavy vehicle traffic. These predicted daily traffic increases would not be noticeable and would not require increases in the sealed road width (which is currently a minimum of 9.0 m).

On the Sturt Highway, south of Balranald, construction traffic would increase traffic volumes by 9% for general traffic and 24% for heavy vehicle traffic. These traffic increases would only affect a relatively short (2.8 km) section of the overall Sturt Highway route and the future daily traffic volumes (in 2018), would remain below the threshold of 3,000 daily vehicle movements, where an increase to the road sealed width (which is currently a minimum of 9.0 m) would be required to meet Austroads rural road design standards.

Along the Balranald-Tooleybuc Road to the existing Tooleybuc Bridge, daily traffic would increase by 12–32% for general traffic and 62–122% for heavy vehicle traffic. These predicted daily traffic increases would be noticeable. However, daily traffic volumes on the rural sections would not increase to above the threshold of 1,000 daily vehicle movements where an increase to the road sealed width (which is currently a minimum of 7 m) would be required to meet Austroads rural road design standards.

RMS has identified that an upgrade/replacement of Tooleybuc Bridge is likely in the future, as summarised in Section 2.2. For the purposes of this TA report, a SIDRA urban intersection capacity assessment has been undertaken for the existing intersection with Murray Street, which is at the eastern end of the bridge. This assesses the traffic capacity of the existing Tooleybuc Bridge (Section 5.3.4).

5.3 Intersection impacts

Assessment of peak construction traffic impacts at intersections has been undertaken based on SIDRA 5.1 intersection capacity analysis. The Sturt Highway and Mayall Street intersection in Balranald town and the Murray Street and Balranald-Tooleybuc Road intersection at Tooleybuc (eastern end of the existing Tooleybuc Bridge), were assessed. The SIDRA intersection capacity analysis results are included as Appendix F.

The reporting parameters for different intersection levels of service are summarised in Table 5.3. The need for intersection improvements has also considered the findings of the RSA (refer Table 3.6) and the assessment by Aurecon of route and intersection turning requirements for oversize vehicles.

Construction phase traffic volumes have been reviewed based on the Austroads Warrant Charts for rural intersections (included in Appendix G). These charts determine the intersection requirements for additional turning lanes with traffic speeds of approximately 100 km/hr or lower.

Table 5.3 Intersection level of service standards

Level of service	Average delay (seconds per vehicle)	Traffic signals, roundabout	Priority intersection ('stop' and 'give way')
A	Less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity At signals, incidents would cause excessive delays Roundabouts require other control mode	At capacity; requires other control mode
F	Greater than 71	Unsatisfactory with excessive queuing	Unsatisfactory with excessive queuing; requires other control mode

Source: RTA (2002).

For rural intersections with traffic speeds of approximately 100 km/hr or higher, and lower traffic speeds (eg 80 km/hr) the combinations of the major road through traffic volumes (two way traffic for right turn movements or following traffic for left turn movements) and turning traffic volumes which would require additional left or right turn traffic lanes, is summarised in Table 5.4.

For intersections with traffic speeds of 100 km/hr or higher there is a minimum major road 'threshold' traffic volume of 120 vehicles/hr below which additional intersection turning lanes are not generally required. For intersections with traffic speeds lower than 100 km/hr (eg 80 km/hr) there is a higher minimum major road 'threshold' traffic volume of 170 vehicles/hr below which turning lanes are not required.

Table 5.4 Austroads hourly traffic volume warrants for additional intersection lanes

Major road – two way traffic volume for right turn lane or following traffic volume for left turn lane (100 km/hr)	Right turning traffic volume for right turn lane or left turning traffic volume for left turn lane (100 km/hr)	Major road – two way traffic volume for right turn lane or following traffic volume for left turn lane (80 km/hr)	Right turning traffic volume for right turn lane or left turning traffic volume for left turn lane (80 km/hr)
Veh/hr	**Veh/hr**	**Veh/hr**	**Veh/hr**
600	5	600	5
500	5	500	7
400	5	400	11
300	8	300	21
250	13	250	33
200	23	200	50
170	34	170	80
150	45	150	No turning lane required
120	80	120	No turning lane required

Source: Austroads 2013.

5.3.1 Project area access intersections

The existing and future intersections which would potentially be used by construction traffic are:

- the intersection of Balranald-Ivanhoe Road and the proposed West Balranald access road, approximately 11 km north of Balranald;
- the intersection of Burke and Wills Road and Balranald-Ivanhoe Road (temporary use only);
- the intersection of Burke and Wills Road and the proposed West Balranald access road, approximately 34 km north-west of Balranald-Ivanhoe Road;
- the intersection of Arumpo Road and Balranald-Ivanhoe Road (temporary use only from Year 5);
- the intersection of Burke and Wills Road and Arumpo Road intersection (part of the Nepean access road from Year 5), approximately 13 km west of the Balranald-Ivanhoe Road; and
- the intersection of Nepean access road (from Year 5) and Arumpo Road, approximately 23 km west of the Balranald-Ivanhoe Road.

At these intersections, the future major road two-way traffic volumes, including construction traffic, will be less than 120 vehicles per hour (the minimum traffic threshold for additional turning lanes at 100 km/hr design speed intersections) and additional left turn or right lane traffic lanes would not be required for normal traffic movements at these intersections.

During the peak construction phase, the anticipated Balranald Project traffic usage of either Arumpo Road, or the northern – most section of Burke and Wills Road would be minimal. No intersection improvements would be required for these roads.

However, at the West Balranald access road intersection with Balranald-Ivanhoe Road, as oversize construction vehicle movements would be occurring on a frequent basis during the construction phase some widening of Balranald-Ivanhoe Road would be required at this intersection.

5.3.2 Balranald-Ivanhoe Road and Balranald town intersections

The future peak hourly construction traffic conditions at the following intersections in Balranald town have been assessed:

- Moa Street and Balranald-Ivanhoe Road;
- McCabe Street and Balranald-Ivanhoe Road;
- Moa Street with O'Connor Street;
- Piper Street, Moa Street, Mayall Street and McCabe Street intersections with Market Street (the Sturt Highway); and
- McCabe Street with Island Road.

At the intersection of Mayall Street with Market Street (the Sturt Highway) which is main town centre intersection at Balranald, three intersection traffic scenarios have been assessed, namely:

- existing 2014 base peak hour traffic;
- the future 2018 base traffic (with annual 2.5% traffic growth and traffic from the Atlas Campaspe Mineral Sands Project); and
- the future 2018 traffic with the Balranald Project construction traffic.

It has been conservatively assumed that all daily traffic from the Atlas Campaspe Mineral Sands Project would coincide with either the existing morning or afternoon peak hour traffic periods at the Mayall Street and Market Street intersection. Approximately 10% of the daily Balranald Project construction phase truck traffic would also travel through this intersection during peak hour periods.

The SIDRA assessment for the modelled intersections is included in Appendix F. A summary of the SIDRA results for each of the six traffic scenarios is provided in Table 5.5.

Table 5.5 Mayall Street/Sturt Highway intersection assessment for peak construction traffic

Year	Peak hour	Traffic demand flow (vehicles)	Average delay (seconds)	LoS[1]	DoS[2]	Maximum queue length (m)
2014 base	Morning peak hour (8.00 to 9.00 am typically)	254	9.7	A	0.072	3
	Afternoon peak hour (4.00 to 5.00 pm typically)	368	10.5	A	0.095	4
2018 base	Morning peak hour (8.00 to 9.00 am typically)	311	10.1	A	0.082	4
	Afternoon peak hour (4.00 to 5.00 pm typically)	437	11.2	A	0.108	5
2018 with Balranald Project construction traffic	Morning peak hour (8.00 to 9.00 am typically)	348	10.4	A	0.086	4
	Afternoon peak hour (4.00 to 5.00 pm typically)	475	11.5	A	0.112	5

Notes: 1. LoS = Level of service.
2. DoS = Degree of saturation.

For all of the traffic scenarios, the intersection would operate at a very low degree of saturation (less than 0.112, ie 11% capacity) and with a high level of service (Level of Service A). There would be minimal average traffic delays (less than 12 seconds per vehicle for the most delayed right turning traffic movements) and minimal intersection queue lengths (less than one vehicle typically on any intersection approach).

All three way or four way intersections in Balranald are essentially similar being either, standard give way or stop sign controlled intersections. The Mayall Street/Sturt Highway intersection is the most heavily trafficked intersection in Balranald town. Minimal construction traffic impacts are predicted for this intersection. It was concluded that further detailed SIDRA intersection capacity analysis of the other Balranald urban area intersections was not necessary.

However, other minor intersection works have been determined to be necessary based on the project RSA recommendations (refer Table 3.6 and Appendix D) and the oversize vehicle route assessment. These intersection improvements, which have been reviewed and modified in some cases by this TA report, are as follows:

- Temporary widening (eg earthworks with fill to allow for trailer swept paths) at five intersections is required to accommodate Balranald Project construction related oversize vehicle movements:
  - Sturt Highway/Murray Bridge Road intersection at Euston- Robinvale;
  - Piper Street/Sturt Highway intersection;
  - Piper Street/O'Connor Street intersection;
  - O'Connor Street/Moa Street intersection; and
  - Moa Street/Balranald-Ivanhoe Road intersection.
- At two intersections, improvements are required based on the recommendations of the Balranald Project RSA, namely:
  - Balranald-Ivanhoe Road/McCabe Street intersection – formalisation of the existing left turn deceleration lane by line marking and construction of appropriate visual barriers and landscaping to remove the 'see through effect' between the Balranald-Ivanhoe Road (north) and McCabe Street approaches to the intersection. Due to the low northbound right turn traffic volumes no provision of a right turn deceleration lane on Balranald-Ivanhoe Road is required from this direction; and
  - McCabe Street/Sturt Highway intersection – minor intersection improvements are required to remove existing encroachments by signage and vegetation within the Sturt Highway road reserve. These would maximise the sight lines for car and truck drivers on McCabe Street (north) and Sturt Highway (south) approaches to the intersection.

5.3.3 Balranald to Tooleybuc

The peak hour traffic conditions at the predominantly rural intersections along the haulage route south of Balranald, including sections of the Sturt Highway south of Balranald and the Balranald-Tooleybuc Road have been assessed, including considerations of the RSA recommendations.

A SIDRA intersection analysis has been undertaken of the urban intersection at Tooleybuc Bridge, where the intersection on the eastern side of the bridge connects Murray Street (south) and the Tooleybuc Bridge (Mallee Highway) with the Balranald Tooleybuc Road (Murray Street North).

5.3.4 Existing Tooleybuc Bridge

The single lane road section of the Tooleybuc Bridge is approximately 150 m long. At the prevailing average travel speed of 30 km/hr for all traffic, a minimum gap of approximately 18 seconds is required between vehicles coming from opposite directions to allow the bridge to be crossed.

The SIDRA assessment results for the bridge are included in Appendix F. The SIDRA results for each of the six modelled traffic scenarios are summarised in Table 5.6.

The existing Tooleybuc Bridge intersection assessment has been undertaken with similar future traffic growth assumptions to the Mayall Street and Market Street (Sturt Highway) intersection analysis, namely 2.5% annual background traffic growth, 50% of the daily construction phase workforce traffic movements, and 10% of the daily construction phase truck traffic movements from the Atlas Campaspe Mineral Sands Project and Balranald Project (which are travelling via Tooleybuc) could potentially be travelling at times which would coincide with the existing morning and afternoon peak hour traffic periods at the existing Tooleybuc Bridge intersection.

For all of the traffic scenarios investigated, the intersection is operating at very low intersection degrees of saturation (less than 0.09, ie about 9% capacity).

The intersection movement with the highest traffic delay is the left turn from the Murray Street (south) approach onto the bridge. This traffic has to give way to all other traffic crossing the bridge from the north and the west. In the 2014 morning and afternoon peak hour traffic analysis scenarios, this movement has a high level of service (Level of Service A) and, minimal average traffic delays of less than 14 seconds per vehicle.

Table 5.6 Existing Tooleybuc Bridge intersection analysis (construction traffic)

Year-Scenario	Peak hour	Traffic demand flow (vehicles)	Average delay (seconds)	LoS[1]	DoS[2]	Maximum queue length (m)
2014 base	Morning peak hour (8.00 to 9.00 am typically)	85	13.9	A	0.057	6
	Afternoon peak hour (4.00 to 5.00 pm typically)	85	13.9	A	0.065	6
2018 base	Morning peak hour (8.00 to 9.00 am typically)	94	14.8	B	0.064	7
	Afternoon peak hour (4.00 to 5.00 pm typically)	93	14.7	B	0.071	7
2018 with Balranald Project traffic	Morning peak hour (8.00 to 9.00 am typically)	117	17.5	B	0.083	9
	Afternoon peak hour (4.00 to 5.00 pm typically)	116	17.4	B	0.090	9

Notes: 1. LoS = Level of service.
2. DoS = Degree of saturation.

Due to future background traffic growth at the intersection (and bridge) the level of service is predicted to decline to Level of Service B in 2018, although there would only be a minor increase in the average delay for the Murray Street (south) left turn traffic movement from approximately 14 to approximately 15 seconds per vehicle, which crosses the service level threshold from 'A' to 'B'.

With the addition of the Balranald Project construction traffic in 2018 there would be a further minor increase in the intersection (ie bridge) delays from approximately 15 to 18 seconds per vehicle. The service level would remain at 'B'. This would be a relatively minor impact which would not warrant any major intersection improvement such as the provision of traffic signals for the bridge.

As all intersections in Tooleybuc are either give way or stop sign controlled and the Murray Street/Tooleybuc Bridge intersection is the most heavily trafficked intersection in Tooleybuc and shows minimal intersection traffic impacts from the Balranald Project construction traffic, it was concluded that further detailed SIDRA intersection capacity analysis of the other Tooleybuc urban area intersections was not necessary.

Also, at other intersections on the Balranald-Tooleybuc Road, between the Sturt Highway and Tooleybuc, the peak hourly two way traffic volumes on the major road are currently below 50 vehicles per hour. With the addition of the Balranald Project construction traffic volumes the future traffic volumes would remain below the minimum threshold of approximately 120 vehicles per hour above which intersection right or left turning traffic lanes could potentially be required for a 100 km/hr design-speed road.

However, at two locations on the haulage route south of Balranald, intersection improvements were identified by the project RSA (refer Table 3.6):

- Sturt Highway/Balranald-Tooleybuc Road intersection – the existing intersection is Austroads Type AUR/AUL which is no longer recommended by Austroads. The recommended Austroads standard is a Type CHR/CHL intersection, details of which are provided in the Austroads design guide extracts in Appendix G. It has been assumed in this TA that these intersection improvement works would be implemented by the relevant road authority (RMS) concurrently with the Balranald Project construction, prior to commencement of the operational phase.

- Tooleybuc Bridge (existing) intersection - the RSA recommended that the existing signage on the bridge approaches should be changed to remove conflicting signage. Also, additional advance intersection signage should be installed on the NSW side of the bridge. Give way signs, with appropriate hold lines marked on the road pavement, should be installed on both the eastern and western bridge approaches, as in practice the bridge traffic restriction is the same for traffic approaching from both directions because traffic cannot proceed onto the bridge in either direction, if there is already a vehicle travelling in the opposite direction on the bridge. It has been assumed in this TA that the improved intersection signage would be implemented by the relevant road authority (RMS) concurrently with the Balranald Project construction, prior to commencement of the operational phase. It is also noted that should the existing Tooleybuc Bridge be replaced prior to commencement of the Balranald Project (refer Section 2.2) these traffic improvements would no longer be required.

5.4 Traffic safety

The Balranald Project intersection traffic safety impacts have been reviewed based on the recommendations of the RSA, assuming that the relevant road and intersection improvements identified above have been implemented.

5.4.1 Project area access

In the vicinity of the Balranald Project (including Burke and Wills Road, Arumpo Road and the Balranald-Ivanhoe Road north of Burke and Wills Road), the roads have a low accident history. There was one traffic accident recorded on the 100 km section of Balranald-Ivanhoe Road, north of Balranald, and none on Burke and Wills or Arumpo Roads between 2009 and 2013.

During the Balranald Project construction phase which has been assessed (from 2015 to 2018), the additional traffic usage on these roads would be relatively minor. The project traffic usage of the northern section of Burke and Wills Road (34 - 46 km north-west of Balranald-Ivanhoe Road) and Arumpo Road from Year 5 during the construction phase of the Nepean mine has been considered under the project operation phase assessment in Section 6.4.1.

5.4.2 Balranald-Ivanhoe Road and Balranald town

Potential traffic safety impacts on the Balranald-Ivanhoe Road and Balranald local roads from the additional construction traffic have been reviewed based on the accident history for these roads and the recommendations of the RSA.

The RSA identified the following road delineation deficiencies requiring improvements along Balranald-Ivanhoe Road and McCabe Street (refer Table 3.6):

- improvements to guidepost system, provision of more warning signs, edge-line and raised reflective pavement markers, at curves on Balranald-Ivanhoe Road between the West Balranald access road intersection and Balranald; and
- provision of edge and centre line markings along the full length of McCabe Street, together with modifications to the curve warning signs and chevron alignment markers for the compound curve section of McCabe Street.

It has been assumed in this TA that these improved road delineation requirements would be implemented during the Balranald Project construction phase.

5.4.3 Balranald to Tooleybuc

Existing road deficiencies have been identified by the RSA for sections of the product haulage route between the Sturt Highway and Tooleybuc.

The RSA identified the following route deficiencies requiring improvements (refer Table 3.6):

- need for improvements to the guidepost system through curvilinear and undulating sections;
- additional curve warning signs and advisory speed limit signs;
- additional chevron alignment markers and raised reflective pavement markers; and
- width marker signs at the two Wakool River Bridges.

It has been assumed in this TA that these improved road delineation and signage requirements would be implemented during the Balranald Project construction phase.

5.5 Road pavement and maintenance impacts

For the product haulage route, a detailed visual pavement condition assessment (Aurecon 2015) has been undertaken with defects logged by type, severity and location using Austroads guidelines.

This work has been used to determine the necessary short term maintenance requirements for these roads, with impacts to the road pavement by Balranald Project construction traffic estimated based on the existing pavement condition assessment from of the Aurecon report.

As the roads inspected are likely to continue to deteriorate (with current traffic volumes) no current, sub-surface investigation or computation checks were carried out on the pavement. These project construction stage maintenance measures are to be considered in combination with the predicted medium to long term pavement maintenance requirements which are outlined in Section 6.5.

5.5.1 Project area access

Sections of existing unsealed local roads, Burke and Wills Road and Arumpo Road, would be used for construction access. A minimum two lanes (ie 8 m) would be maintained along these existing unsealed roads during construction access. Road cross-sections would be regraded during the construction phase to minimise corrugations, potholes and other surface defects.

5.5.2 Balranald-Ivanhoe Road and Balranald township

For the sections of Balranald-Ivanhoe Road and McCabe Street, which are part of the proposed product haulage route, the short term rehabilitation strategy would be based around rectifying existing pavement defects which were deemed to require urgent maintenance repairs. These works should be undertaken during the normal maintenance cycle for these roads prior to the commencement of the major project construction and operational phases.

The following existing pavement deficiencies were identified for the inspected sections of Balranald-Ivanhoe Road (9.5 km):

- 2% of pavement area affected by solitary cracking;
- 6% of pavement area affected by multiple cracking;
- 1% of pavement area affected by cracking and rutting;
- 1% of pavement area affected by crocodile cracking;
- 2% of pavement area affected by surface deformation; and
- 17% of pavement area affected by other surface defects (primarily texture loss).

The following existing pavement deficiencies were identified for the inspected sections of McCabe Street (1.8 km):

- 7% of pavement area affected by solitary cracking;
- 0% of pavement area affected by multiple cracking;
- 0% of pavement area affected by cracking and rutting;
- 3% of pavement area affected by crocodile cracking;
- 0% of pavement area affected by surface deformation; and
- 58% of pavement area affected by other surface defects (primarily texture loss).

The short term remedial program of road maintenance for these roads should address existing specific deficiencies (eg cracks, potholes, failed patches, high severity rutting and shape loss). These remedial works should be completed by the relevant road authority within the next 1-2 years as part of routine maintenance activities (ie prior to commencement of the proposed product haulage operations).

It has been assumed in this TA that the short term pavement maintenance would be implemented by the relevant road authority (BSC) prior to commencement of the Balranald Project product haulage.

5.5.3 Balranald to Tooleybuc

Sections of the Sturt Highway and Balranald-Tooleybuc Road which would form part of the proposed product haulage route within NSW would also be used by some Balranald Project construction traffic.

For these roads, the short - term rehabilitation strategy would be based around rectifying existing pavement defects which require urgent maintenance. These works should be undertaken during the normal maintenance cycle for these roads prior to the commencement of the project construction and operational phases.

The following existing pavement deficiencies were identified for the inspected sections of the Sturt Highway (2.8 km):

- 2% of pavement area affected by solitary cracking;
- 0% of pavement area affected by multiple cracking;
- 0% of pavement area affected by cracking and rutting;
- 0.02% of pavement area affected by crocodile cracking;
- 1% of pavement area affected by surface deformation; and
- 26% of pavement area affected by other surface defects (primarily texture loss).

The following existing pavement deficiencies were identified for the inspected sections of Balranald-Tooleybuc Road (53.9 km):

- 1% of pavement area affected by solitary cracking;
- 0.2% of pavement area affected by multiple cracking;
- 0.1% of pavement area affected by cracking and rutting;
- 0.4% of pavement area affected by crocodile cracking;
- 2% of pavement area affected by surface deformation; and
- 9% of pavement area affected by other surface defects (primarily texture loss).

The short- term remedial program of road maintenance for these roads should address existing specific deficiencies (eg cracks, potholes, failed patches, high severity rutting and shape loss). These remedial works should be completed by the relevant road authority within the next 1-2 years as part of routine maintenance activities (ie prior to the commencement of product haulage operations).

It has been assumed in this TA that the short term pavement maintenance would be implemented by the relevant road authority (RMS) prior to commencement of the Balranald Project product haulage.

5.6 Car parking

Construction phase car parking areas would be provided to meet demand at all identified Balranald Project worksites and at the accommodation facility.

5.7 Public transport

No public transport improvements are required for the construction phase. Extensive use of shuttle bus transport is envisaged for construction workforce travel between the accommodation facility and construction worksites, plus a daily bus service to and from the regional airport at Mildura for FIFO workers.

The project workforce shuttle buses would primarily travel via the West Balranald access road, although at times, up to 30% of these buses may travel via other routes (primarily Burke and Wills Road) to access northern parts of the project area during construction of the West Balranald access road and internal road network.

5.8 Pedestrian and cyclist access

Due to the remote nature of the project area, access by the workforce using either cycling or walking is not envisaged.

6 Operational phase impacts

6.1 Traffic generation

Traffic generation during the operational phase of the Balranald Project is described in Section 4.5.2. The operational phase impact assessment has assumed background traffic to have a linear growth rate of 2.5% per annum. Predicted operations phase traffic from the Atlas-Campaspe Mineral Sands Project (GTA 2012) has also been included, as it would also potentially contribute to higher traffic levels on the road network assessed. Peak traffic generation from the operational phase is predicted to occur in 2020.

The predicted changes to base traffic volumes are presented in Table 6.1. By 2020, the daily traffic volumes surveyed in 2014 would have increased by 15% and traffic volumes surveyed in 2006 would have increased by around 35%.

Table 6.1 Adjustments to existing daily traffic volumes (2020)

Road name	Local traffic growth	Local traffic growth	Atlas-Campaspe project traffic	Atlas-Campaspe project traffic	Future base scenario traffic	Future base scenario traffic
Vehicle type	**All traffic**	**Heavy vehicles**	**All traffic**	**Heavy vehicles**	**All traffic**	**Heavy vehicles**
Balranald-Ivanhoe Road (north of Oxley Road)	68	17	94	8	162	25
Balranald-Ivanhoe Road (5 km north of Sturt Highway)	350	88	94	8	444	96
Balranald-Ivanhoe Road (north of Moa Street)	481	114	94	8	575	122
Mayall Street (north of Market Street)	817	82	61	6	878	88
McCabe Street (southern end)	158	64	6	2	164	66
Sturt Highway (1 km south of Balranald)	1,697	570	6	2	1,703	572
Sturt Highway (east of MR 67 Balranald-Tooleybuc Rd)	1,308	458	6	2	1,314	460
Sturt Highway (Euston, east of Murray Bridge Road)	1,640	574	27	0	1,667	574
Balranald-Tooleybuc Road (northern section)	643	155	0	0	643	155
Balranald-Tooleybuc Road (southern section)	443	106	0	0	443	106
Balranald-Tooleybuc Road (at existing Tooleybuc Bridge)	1,140	207	0	0	1,140	207
Arumpo Road (western section)	35	4	0	0	35	4
Arumpo Road (eastern section)	23	2	0	0	23	2
Burke and Wills Road (northern end)	12	1	0	0	12	1
Burke and Wills Road (southern end)	23	2	0	0	23	2

Table 6.1 Adjustments to existing daily traffic volumes (2020)

Road name	Local traffic growth	Local traffic growth	Atlas-Campaspe project traffic	Atlas-Campaspe project traffic	Future base scenario traffic	Future base scenario traffic
Piper Street (at Sturt Highway)	81	8	0	0	81	8
Moa Street (at Sturt Highway)	414	21	27	0	441	21
Moa Street (north of O'Connor Street)	115	12	27	0	142	12
O'Connor Street (west of Moa Street)	138	14	0	0	138	14
Market Street Sturt Highway (west of Mayall Street)	3,375	625	0	0	3,375	625

It has been assumed that approximately half the predicted operational traffic from the Atlas Campaspe mineral sands project travelling to and from the Mildura area (27 vehicle trips daily) would be using the shorter direct route via Wampo and the remaining half of this traffic (also 27 vehicle trips daily) would be travelling via Balranald using the Balranald- Ivanhoe Road and Sturt Highway route.

6.2 Road carriageway impacts

The predicted increases to traffic volumes during the peak operational phase (2020) are summarised in Table 6.2. During peak hourly traffic periods, it is assumed that 50% of the total daily workforce car traffic movements, 10% of the total daily truck delivery traffic movements and 4% of the total daily product haulage truck traffic movements could occur at any assessed location in Table 6.2.

The product haulage routes to Victoria (Manangatang, Hopetoun or Hamilton), are shown in Figure 4.5.

On the Nepean access road, ore would be transported from the Nepean mine to the West Balranald mine. This would require one truck movement in each direction every five minutes, or approximately 500 vehicle movements daily, by B-Triple road train trucks, between Year 6 and Year 8 of the operational phase. These traffic movements, which would occur after 2020, are not included in the assessment in Table 6.2 and have been considered separately in the route assessments for Arumpo Road in Section 6.2.1.

6.2.1 Project area access

On the local project area access routes, primarily Arumpo Road, the maximum (non-haul) Balranald Project operational phase traffic would be approximately 24 daily vehicle movements. This would consist of a combination of car/light vehicle traffic between the accommodation facility and operational phase worksites, delivery trucks and workforce shuttle bus movements.

The additional operational phase traffic using Arumpo Road would be noticeable compared to the existing daily traffic (refer Table 6.2). However, the combined future total daily traffic movements would be in the range 47 to 59 vehicle movements daily, which is below the level where sealing of the road is recommended (approximately 150 vehicle movements daily).

There would be only occasional Balranald Project operational phase traffic usage on the eastern section of Burke and Wills Road, during 2020 as the West Balranald access road would be available by then to carry operational phase traffic.

Table 6.2 Assessed Balranald Project daily operational phase traffic increases for each route in 2020

Road name	Average daily base traffic (2020)	Average daily base traffic (2020)	Project daily traffic	Project daily traffic	Total daily traffic	Total daily traffic	Percent traffic increase (all vehicles)	Percent traffic increase (heavy vehicles
Vehicle type	**All traffic**	**Heavy**	**All traffic**	**Heavy**	**All traffic**	**Heavy**	**%**	**%**
Balranald-Ivanhoe Road (north of Oxley Road)	162	25	24	12	186	37	15	48
Balranald-Ivanhoe Road (5 km north of Sturt Highway)	444	96	354	202	798	298	80	210
Balranald-Ivanhoe Road (north of Moa Street)	575	122	354	202	929	324	62	166
Mayall Street (north of Market Street)	878	88	78	16	956	104	9	18
McCabe Street (southern end)	164	66	190	160	354	226	116	242
Sturt Highway (1 km south of Balranald)	1,703	572	190	160	1,893	732	11	28
Sturt Highway (east of Balranald-Tooleybuc Rd)	1,314	460	20	5	1,334	465	2	1
Sturt Highway (Euston, east of Murray Bridge Road)	1,667	574	86	26	1,753	600	5	5
Balranald-Tooleybuc Road (northern section)	643	155	170	155	813	310	26	100
Balranald-Tooleybuc Road (southern section)	443	106	170	155	613	261	38	146
Balranald-Tooleybuc Road (existing Tooleybuc Bridge)	1,140	207	170	155	1,310	362	15	75
Arumpo Road (western section)	35	4	24	12	59	16	69	300
Arumpo Road (eastern section)	23	2	24	12	47	14	104	600
Burke and Wills Road (northern end)	12	1	0	0	12	1	0	0
Burke and Wills Road (southern end)	23	2	0	0	23	2	0	0
Piper Street (at Sturt Highway)	81	8	24	24*	105	32	30	300*
Moa Street (at Sturt Highway	441	21	62	2*	503	23	14	10*
Moa Street (north of O'Connor Street)	142	12	86	26*	228	38	61	217*
O'Connor Street (west of Moa Street)	138	14	24	24*	162	38	17	171*
Market Street Sturt Highway (west of Mayall Street)	3,375	625	26	5	3,401	630	1	1

Notes: **as a mitigation measure Iluka would seek to redirect the majority of heavy vehicles travelling from Mildura to use the McCabe Street bypass to minimise impacts to these residential areas.*

The northern section of Burke and Wills Road and the western section of Arumpo Road (between Burke and Wills Road and the Nepean access road) would be upgraded to accommodate the proposed mine ore transport operation (approximately 500 vehicle movements daily by large trucks) during Year 6 to Year 8.

These upgrades would generally provide a minimum eleven metre wide two lane 'all weather' gravel road surface, appropriate for traffic safety for all road users, but would not be required until the commencement of Nepean mine operations (Year 6) as these road sections would not be used by significant additional mine traffic until that time.

For the Burke and Wills Road section of the Nepean access road the unsealed road width could potentially be reduced to 8 m if locality traffic management restrictions are implemented. These should clearly signpost the alternative (mainly sealed) travel route from Balranald, to Lake Mungo via Arumpo Road for tourist traffic and other local non-mining traffic. This would also require the road authorities to be satisfied that there would be minimal future traffic safety conflicts between the operational phase (mine ore transport) traffic and other non-mining traffic using Burke and Wills Road. Additionally if a narrower unsealed road width than 11 m is used, a lower speed limit than 100 km/hr (ie 80 km/hr) should be clearly signposted for all traffic using the route.

6.2.2 Balranald-Ivanhoe Road

On sections of Balranald-Ivanhoe Road outside the Balranald urban area, (ie between Moa Street and the West Balranald access road) the maximum operational phase traffic volume would be approximately 354 daily vehicle movements. This would consist of car/light vehicle traffic, delivery truck movements and product haulage truck traffic.

The operational worker shuttle bus movements between the accommodation facility and worksites would primarily occur on the West Balranald access road. There would be minimal other workforce travel movements (those involving airport transfers) and a relatively small number of locally based operational workers travelling daily on Balranald-Ivanhoe Road south of the West Balranald access road intersection.

There would be low Balranald Project operational traffic use of Balranald-Ivanhoe Road, north of Burke and Wills Road, accessing the Nepean mine. This traffic would not commence until Year 5 (for Nepean mine construction activity) and Year 6 onwards for the Nepean mine operation. There would be minimal Balranald Project operational workforce or truck traffic travelling on Balranald-Ivanhoe Road, north of Burke and Wills Road, to and from the Ivanhoe direction.

The Balranald Project operational traffic using Balranald-Ivanhoe Road south of the West Balranald access road, would result in a 62–80% increase to the future daily traffic and a 166–210% increase in the heavy vehicle traffic volume. The combined traffic volume would be in the range 798 to 929 daily vehicle movements. This would be below the level where widening of the existing 7.0 m road sealed width would be required to meet Austroads road design standards (approximately 1,000 vehicle movements daily).

On the sections of Balranald-Ivanhoe Road leading to the town centre (Mayall Street), there would be approximately 78 daily vehicle movements, due to the dispersal of much Balranald Project traffic onto other routes (eg McCabe Street, Moa Street, O'Connor Street and Piper Street). The traffic volume on Mayall Street would increase by approximately 9% (all traffic) and 18% (heavy vehicles) due to Balranald Project operations.

This traffic increase would not affect intersection operations on Mayall Street andthe future intersection capacity of the Mayall Street and Market Street (Sturt Highway) intersection which has been assessed using SIDRA (Section 6.3.2).

6.2.3 Balranald town roads

The predicted traffic volume increases on the roads through Balranald town are summarised in Table 6.2 for McCabe, Moa, Piper and O'Connor Streets and Market Street (the Sturt Highway). The daily traffic volumes on these streets would increase by between 1% on Market Street and 61% on Moa Street, north of O'Connor Street.

On Market Street, the predicted daily traffic increases would not be noticeable for either general or heavy vehicle traffic.

On McCabe Street, the predicted daily traffic increases would be approximately 116% for general traffic and 242% for heavy vehicle traffic. McCabe Street provides an eastern heavy vehicle bypass route around the town of Balranald. The overall daily traffic in 2020 would increase to approximately 354 vehicle movements daily. As outlined in Section 5.2.3, in the absence of traffic from the Balranald Project (construction or operational) the predicted daily traffic by 2018 would exceed the Austroads road design standards requiring the road sealed width to be increased to 7 m the project. Operational traffic (particularly the significant anticipated heavy vehicle traffic usage) will also warrant an increase in the road sealed width to 7 m to meet Austroads design standards.

On Piper Street and O'Connor Street, the predicted daily traffic would increase by 17 to 30% for all traffic and up to 300% for heavy vehicle traffic but the overall daily traffic using these roads would remain at between 105-162 vehicle movements daily. This would not generally require any increase to the existing sealed width for these roads. However, as outlined in Section 5.3.2, additional earthworks (eg fill) would be provided at some intersections to accommodate swept path for oversize vehicle movements on these roads during the construction phase.

On Moa Street north of O'Connor Street, as outlined in Section 5.2.3 in the absence of traffic from the Balranald Project (construction or operational) the predicted daily traffic by 2018 would exceed the Austroads road design standards requiring the road sealed width to be increased to 7 m. Traffic from the Balranald Project operatios (86 vehicle movements daily – refer Table 6.2) would have no additional traffic effect on this route compared to the construction phase traffic impacts which are assessed in Table 5.1 and Table 5.2.

On Moa Street south of O'Connor Street, the predicted daily traffic increases from the project would be primarily light vehicle traffic and the predicted daily traffic increases would be much lower, approximately 14% for all traffic, for Moa Street, north of the Sturt Highway, which should be acceptable for this street.

In order to minimise the potential traffic impacts to residential areas on routes such as Piper Street, O'Connor Street and Moa Street, Iluka would seek to direct all the project operational heavy vehicle traffic which is travelling to and from the west of Balranald (from the Robinvale and Mildura direction) to travel via McCabe Street and the Sturt Highway route (Market Street) while travelling through Balranald.

6.2.4 Sturt Highway and Balranald - Tooleybuc Road

The Balranald Project operations traffic would increase daily traffic volumes on the Sturt Highway to the east and west of Balranald by between 2% to 5% for all traffic and by between 1% to 5% for heavy vehicle traffic. These predicted daily traffic increases would not be noticeable and would not require increases in the road sealed width (which is currently a minimum of 9.0 m) on the route.

On the product haulage route section of the Sturt Highway, which is to the south of Balranald, the daily traffic would increase by 11% for general traffic and 28% for heavy vehicle traffic. These traffic increases would only affect the relatively short (2.8 km) section of the Sturt Highway south of Balranald and the future daily traffic volumes (in 2020), would remain below the threshold of 3,000 daily vehicle movements, where an increase to the road sealed width would be required to meet Austroads rural road design standards.

On the Balranald-Tooleybuc Road sections of the product haulage route to the existing Tooleybuc Bridge, the daily traffic increases (in 2020) would range from 26% to 38% for all traffic and from 100% to 146% for heavy vehicle traffic. These predicted daily traffic increases would be potentially noticeable for other traffic using the route but would not increase the overall daily traffic volumes on the rural sections to above the threshold of 1,000 daily vehicle movements where an increase to the road sealed width (which is currently a minimum of 7.0 m) would be required to meet Austroads rural road design standards.

A separate intersection capacity assessment has also been undertaken for the Tooleybuc Bridge traffic operations with and without the project operation traffic (Section 6.3.3).

6.3 Intersection impacts

The assessment of the Balranald Project operational traffic at intersections in 2020 has been undertaken based on SIDRA intersection capacity analysis for the main town centre intersection at Balranald (the Sturt Highway/Mayall Street intersection) and the intersection at Tooleybuc, at the eastern end of the existing Tooleybuc Bridge, using the same method as for the Balranald Project construction transport assessment.

6.3.1 Project area access

The project area access route intersections with Balranald-Ivanhoe Road and other routes include:

- the intersection of Balranald-Ivanhoe Road and the West Balranald access road, approximately 11 km north of Balranald;
- the intersection of the Nepean access road with Burke and Wills Road, approximately 34 km north-west of Balranald-Ivanhoe Road;
- the intersection of Balranald-Ivanhoe Road and Arumpo Road, approximately 53 km north of Balranald;
- the intersection of Burke and Wills Road and Arumpo Road, approximately 13 km west of Balranald Ivanhoe Road; and
- the intersection of the Nepean access road and Arumpo Road, approximately 23 km west of Balranald-Ivanhoe Road.

The future major road traffic volumes at these intersections, including project operations traffic, will be less than 120 vehicles per hour. This is the minimum traffic threshold where additional turning lanes may be required at 100 km/hr design speed intersections and left turn or right lane traffic lanes are not required for normal traffic usage at these intersections, regardless of the future intersection turning traffic volumes.

However at the new West Balranald access road intersection with Balranald- Ivanhoe Road, widening of the major road would be desirable to provide a left turning traffic lane, for use by decelerating trucks, in view of the high proposed truck traffic usage at the intersection for the mine product haulage operation (150 daily vehicle movements by B-Double trucks).

Also, at the Burke and Wills Road and Arumpo Road intersection, where both these roads are currently unsealed, the intersection approaches should be sealed for at least 50 and 100 m respectively during the proposed ore transport operation between the Nepean and West Balranald mine deposits, from Year 6 to Year 8. This would improve the future intersection traffic visibility and safety for turning traffic, improve visibility (by reducing dust at intersection location) and also reduce the potential for excessive road pavement wear from vehicles turning at the intersection.

6.3.2 Balranald-Ivanhoe Road and Balranald town intersections

The future peak hourly traffic conditions at Balranald town intersections have been investigated at a number of intersections, including Moa Street and McCabe Street on Balranald-Ivanhoe Road; Piper, Moa, Mayall and McCabe Street along Market Street (the Sturt Highway); the intersections of Moa Street with O'Connor Street and McCabe Street with Island Road.

The Mayall Street and Market Street (Sturt Highway) intersection, which is the main town centre intersection, is the most heavily trafficked intersection in Balranald town and has been assessed for the existing 2014 base peak hour traffic, the 2020 base traffic (with locality traffic growth and traffic from the Atlas Campaspe mineral sands project) and the 2020 traffic with the additional Balranald Project operational traffic.

The intersection traffic impacts have been assessed conservatively, assuming 2.5% locality traffic growth each year and all the daily operational phase workforce traffic movements from both the Atlas Campaspe and Balranald mineral sands projects that travels via Mayall Street through the centre of Balranald, would travel through the town centre at times which coincide with the existing morning and afternoon peak hour traffic periods at the Mayall Street and Market Street intersection.

The SIDRA assessment results are included in Appendix F. A summary of the SIDRA intersection results for each of the six traffic scenarios considered is provided in Table 6.3.

Table 6.3 Mayall Street/Sturt Highway intersection at Balranald (operational traffic)

Year-Scenario	Peak hour	Demand flow (vehicles)	Average delay (seconds)	LoS[1]	DoS[2]	Maximum queue length (m)
2014 Base	Morning peak hour (8.00 to 9.00 am typically)	254	9.7	A	0.072	3
	Afternoon peak hour (4.00 to 5.00 pm typically)	368	10.5	A	0.095	4
2020 Base	Morning peak hour (8.00 to 9.00 am typically)	323	10.3	A	0.086	4
	Afternoon peak hour (4.00 to 5.00 pm typically)	456	11.5	A	0.113	5

Table 6.3 Mayall Street/Sturt Highway intersection at Balranald (operational traffic)

Year-Scenario	Peak hour	Demand flow (vehicles)	Average delay (seconds)	LoS[1]	DoS[2]	Maximum queue length (m)
2020 With Balranald Project traffic	Morning peak hour (8.00 to 9.00 am typically)	367	10.6	A	0.090	4
	Afternoon peak hour (4.00 to 5.00 pm typically)	500	11.8	A	0.118	5

Notes: 1. LoS = Level of service.
2. DoS = Degree of saturation.

For all of the traffic scenarios considered tin Table 6.3, the intersection would operate at a very low degree of saturation (less than 0.118, about twelve per cent of capacity) and with a high level of service (Level of Service A). There would be minimal average traffic delays (less than 12 seconds per vehicle) for the most delayed right turning traffic movements, and minimal intersection traffic queue lengths (less than one vehicle typically on any intersection approach).

As all intersections in Balranald have give way or stop sign control and the Mayall Street/Sturt Highway intersection is the most heavily trafficked intersection in Balranald town and shows minimal predicted traffic impacts from the Balranald Project operational traffic, It was concluded that further detailed SIDRA intersection capacity analysis of the other Balranald urban area intersections for the Balranald Project operational traffic, was not necessary.

However, at a number of other intersections within Balranald, minor intersection earthworks (eg fill to provide sufficient swept path for oversize vehicle movements) were determined to be necessary for the Balranald Project construction traffic (refer Section 5.3.2).

6.3.3 Balranald to Tooleybuc

The peak hour traffic conditions at the predominantly rural intersections along the haulage route south from Balranald, including the 2.8 km section of the Sturt Highway and the full length of the Balranald-Tooleybuc Road have been investigated.

At the rural intersections on the Balranald-Tooleybuc Road, between the Sturt Highway and Tooleybuc, the peak hourly two way traffic volumes on the major road are currently below 50 vehicles per hour and with background traffic growth (to 2020) and the potential addition of the future Balranald Project operational traffic volumes (up to 14 hourly vehicle movements), the future total hourly volumes would still remain below the minimum threshold volume of approximately 120 hourly vehicles, above which intersection right or left turning traffic lanes are potentially required for a 100 km/hr design speed road.

A SIDRA intersection analysis, using the same method and assumptions for the construction transport assessment (refer Section 5.3.4), was undertaken for the approach routes at the existing Tooleybuc Bridge. The SIDRA modelled intersection layout and the results from the intersection are included in Appendix F and summarised for each of the six modelled scenarios in Table 6.4.

For all of the traffic scenarios considered, the intersection would operate at very low intersection degrees of saturation (less than 0.09, about 9% of capacity).

The intersection movement with the highest traffic delay would be the left turn movement from the Murray Street (south) approach onto the bridge which has to give way to all traffic which is crossing the existing Tooleybuc Bridge from either the north or west. In the current morning and afternoon peak hour 2014 traffic analysis scenarios, this movement has a high level of service (level of Service A), with minimal average delays of less than fourteen seconds per vehicle for the Murray Street (south) approach (refer Table 6.4).

However, as determined for the construction transport assessment (refer Section 5.3.4), the future background traffic growth by 2020 would reduce the intersection (and bridge) level of service to Level of Service B, even though there would be only minor increases in the actual average delays for the Murray Street (south) traffic movement at the intersection.

With the addition of the Balranald Project operational phase traffic movements at this intersection, there would be a further minor increase in the average intersection (and bridge) operating delays from approximately 15 to 17 seconds per vehicle. However, this relatively minor impact would not warrant any major intersection improvement, such as traffic signs for the bridge operation.

Table 6.4 Existing Tooleybuc Bridge intersection analysis (operational traffic)

Year-Scenario	Peak hour	Demand flow (vehicles)	Average delay (seconds)	LoS[1]	DoS[2]	Maximum queue length (m)
2014 Base	Morning peak hour (8.00 to 9.00 am typically)	85	13.9	A	0.057	6
	Afternoon peak hour (4.00 to 5.00 pm typically)	85	13.9	A	0.065	6
2020 Base	Morning peak hour (8.00 to 9.00 am typically)	98	15.3	B	0.067	7
	Afternoon peak hour (4.00 to 5.00 pm typically)	98	15.3	B	0.076	8
2020 With Balranald Project traffic	Morning peak hour (8.00 to 9.00 am typically)	115	17.2	B	0.081	9
	Afternoon peak hour (4.00 to 5.00 pm typically)	115	17.2	B	0.090	9

Notes: 1. LoS = Level of service.
2. DoS = Degree of saturation.

All intersections in Tooleybuc are either give way or stop sign controlled. This intersection is the most heavily trafficked intersection and shows minimal predicted impacts from the Balranald Project traffic, it was therefore concluded that further detailed SIDRA intersection capacity analysis of the other Tooleybuc area intersections would not be necessary for the Balranald Project operational traffic.

However, from the Balranald Project RSA, intersection improvements were recommended at other locations on the project haulage route south of Balranald. These are listed and discussed in the Balranald Project construction phase traffic impacts assessment in Section 5.3.3.

6.4 Traffic safety

6.4.1 Local mine access routes

During Balranald Project operations, the additional mine workforce and delivery traffic on local roads would be minor (and primarily limited to Arumpo Road during the construction of the Nepean mine from Year 5The proposed improvements to Burke and Wills Road and Arumpo Road (refer Section 6.2.1) for the sections which are likely to be used by Balranald Project construction or operational traffic, would more than compensate for any potential safety impacts from the additional project-related traffic usage.

At the Burke and Wills Road and Arumpo Road intersection, where both these roads are currently unsealed, the intersection approaches should be sealed for at least 50 and 100 m respectively during the proposed ore transport operation between the Nepean and West Balranald mine deposits, from Year 6 to Year 8. This would improve the future intersection traffic visibility and safety for turning traffic, visibility (by reducing dust at intersection location) and also reduce the potential for excessive road pavement wear from vehicles turning at the intersection.

6.4.2 Balranald-Ivanhoe Road and Balranald town

Potential safety impacts on Balranald-Ivanhoe Road and within Balranald town from the additional Balranald Project operational traffic have been reviewed based on the accident history for these roads and the RSA recommendations.

Assuming the RSA identified deficiencies along Balranald-Ivanhoe Road, and McCabe Street have been rectified concurrently with the construction phase, no additional route safety improvements would be required for the Balranald Project operational traffic.

6.4.3 Balranald to Tooleybuc

A number of route traffic safety deficiencies have been identified by the RSA for the sections of the haulage route between the Sturt Highway and Tooleybuc. Assuming the RSA identified deficiencies have been rectified concurrently with the construction phase, no additional route traffic safety improvements would be required for the Balranald Project operations phase.

6.5 Road pavement and maintenance impacts

Balranald Project road pavements impacts would primarily occur from the product haulage and associated backloading (150 maximum daily truck movements) on the proposed haulage route, although some other route impacts may also occur on the unsealed local mine access routes.

Impacts to the road pavement by Balranald Project operational traffic have been analysed in *Haulage Route Pavement Strength Review* (Aurecon 2015). The predicted haulage route impacts considered the results of the detailed visual pavement condition assessment which logged the existing defects by type, severity and location along the haulage route, using Austroads guidelines.

The recommended medium to long - term maintenance strategies (Aurecon 2015) for each section of the route will primarily include treatments such as sprayed seals and asphalt overlays, which are suitable for design traffic loadings which have been calculated in equivalent standard axles (ESA) for each section of the route, ie:

- for sections of the haulage route with a design traffic loading greater than 3 million ESA, a 40 mm asphalt overlay is recommended as this provides a more durable surface course layer that is more resistant to repeated traffic and heavy wheel loads;
- for sections with a design traffic loading between 1 million and 3 million ESA, a double seal surface treatment is recommended;
- for sections with a design traffic loading of less than 1 million ESA, a single seal surface treatment is recommended; and
- ongoing surface maintenance such as crack sealing, asphalt patching, pothole repairs and localised surface treatments would continue to be undertaken on a regular basis throughout each year, the frequency and extent of these treatments would be greater for the sections with higher design traffic.

6.5.1 Local mine access routes

Sections of Burke and Wills Road and Arumpo Road incorporated into the Nepean access road would be used for Balranald Project construction and operational activities, including the ore transport between the mines (Year 6 to Year 8).

These sections would be upgraded to a 'haul road' standard which would provide a two lane wide unsealed gravel road surface (refer Table 7.1). The surfaces would be maintained by Iluka by grading to prevent the development of corrugations, potholes and other surface defects which could potentially affect the route ride-ability and safety for all road users.

6.5.2 Product haulage route

The future project life road maintenance costs for each NSW section of the haulage route were estimated by (Aurecon 2015) based on the future road pavement axle loadings for each section of the haulage route, for the base case without the Balranald Project proceeding and for the following four product haulage scenarios:

- Scenario 1, transport of HMC only using GML trucks, 35 trucks per day each way, representing 70 daily truck movements;
- Scenario 2, transport of HMC and ilmenite using GML trucks, 75 trucks per day each way, representing 150 daily truck movements;
- Scenario 3, transport of HMC only using HML trucks, 31 trucks per day each way, representing 62 daily truck movements; and
- Scenario 4, transport of HMC and ilmenite using HML trucks, 68 trucks per day each way, representing 136 daily truck movements.

The base and project case road pavement axle loadings for each of these scenarios for the relevant sections of the haulage route and the increases in comparison to the base case loadings for the Balranald bound and the Manangatang bound traffic, are presented in Table 6.5.

Table 6.5 Haulage route design axle loadings over the life of the Balranald Project

Scenario	Road	Design equivalent standard axles (DESA)[1]					
		Base case: Balranald-bound	Base case: Manangatang -bound	Project case: Balranald-bound	Project case: Manangatang - bound	Increase from base Balranald-bound (%)	Increase from base: Manangatang - bound(%)
1	Balranald-Ivanhoe Road	375,079	436,323	976,832	1,038,077	161	138
	McCabe Street	227,996	266,931	829,749	868,685	264	226
	Sturt Highway	2,717,104	2,588,223	3,318,858	3,189,977	23	24
	Balranald-Tooleybuc Road	480,273	645,089	1,082,027	1,246,843	126	94
2	Balranald-Ivanhoe Road	375,079	436,323	1,581,856	1,725,795	322	296
	McCabe Street	227,996	266,931	1,434,773	1,556,403	530	484
	Sturt Highway	2,717,104	2,588,223	3,923,882	3,877,695	45	50
	Balranald-Tooleybuc Road	480,273	645,089	1,687,051	1,934,561	252	200
3	Balranald-Ivanhoe Road	375,079	436,323	1,037,101	1,185,829	177	172
	McCabe Street	227,996	266,931	890,018	1,016,437	290	281
	Sturt Highway	2,717,104	2,588,223	3,379,126	3,337,729	24	29
	Balranald-Tooleybuc Road	480,273	645,089	1,142,296	1,394,595	138	116
4	Balranald-Ivanhoe Road	375,079	436,323	1,831,692	2,080,400	388	377
	McCabe Street	227,996	266,931	1,684,608	1,911,008	639	616
	Sturt Highway	2,717,104	2,588,223	4,173,717	4,232,300	54	64
	Balranald-Tooleybuc Road	480,273	645,089	1,938,886	2,289,166	303	255

Notes: 1. DESA: Design Equivalent Standard Axles based on the standard maximum 8.5 tonne axle loading for heavy vehicles.

The pavement maintenance and repair treatment options which may be used for various sections of the haulage route vary, depending on the existing pavement condition and the future road pavement axle loading. The costs per m^2 of the fourteen alternative maintenance treatments considered in the analysis are provided in Table 6.6.

Table 6.6 Pavement maintenance and repair treatments

Treatment option	Description	Design traffic loading (DESA)	Unit cost ($/m^2)[1]
Resurface treatments			
1	Crack sealing	Crack sealing	$15
2	Spray Seal Type 1	≤1 million	$15
3	Spray Seal Type 2	1 million–3 million	$20
4	Asphalt	>3 million	$30
Patching rehabilitation treatments			
5	Type 1	≤0.5 million	$55
6	Type 2	0.5 million–3 million	$60
7	Type 3	3 million–4 million	$65
8	Type 4	>4 million	$70
Full depth reconstruction			
9	Type 1	≤0.5 million	$68
10	Type 2	0.5 million–3 million	$80
11	Type 3	3 million–4 million	$90
12	Type 4	>4 million	$100
Other			
13	Pothole repair	All	$75
14	Reshape and rectify table drains	All	$25

Notes: 1. Aurecon (2015) based on 2014 and not adjusted for future years.

The calculated future pavement maintenance cost for each road section, based on the treatment type, is provided in Table 6.7 and Table 6.8 for the base case and the project GML and HML haulage scenarios.

Table 6.7 Estimated pavement base and GML haulage maintenance costs (Scenarios 1 and 2)

Road section	Base case		Scenario 1 minimum haulage with GML axle loadings		Scenario 2 maximum haulage with GML axle loadings	
	Treatment type	Cost	Treatment type	Cost	Treatment type	Cost
Balranald-Ivanhoe Road	1	$81,000	1	$82,000	1	$82,000
	2	$1,028,000	3	$1,410,000	3	$1,410,000
	5	$65,000	6	$72,000	6	$72,000
	9	$25,000	10	$30,000	10	$30,000
	13	$1,000	13	$1,500	13	$1,500
	14	$27,000	14	$27,000	14	$27,000
Subtotal		*$1,227,000*		*$1,622,500*		*$1,622,500*
McCabe Street	1	$15,000	1	$15,000	1	$16,000
	2	$205,000	2	$205,000	3	$277,000
	13	$500	13	$500	13	$1,000
	14	$33,000	14	$33,000	14	$33,000
Subtotal		*$253,500*		*$253,500*		*$327,000*

Table 6.7 Estimated pavement base and GML haulage maintenance costs (Scenarios 1 and 2)

Road section	Base case		Scenario 1 minimum haulage with GML axle loadings		Scenario 2 maximum haulage with GML axle loadings	
	Treatment type	Cost	Treatment type	Cost	Treatment type	Cost
Sturt Highway	1	$6,000	1	$7,000	1	$7,000
	4	$620,000	4	$620,000	4	$620,000
	6	$13,000	7	$14,000	7	$14,000
	10	$1,000	11	$1,000	11	$1,000
	12	$1,000	13	$1,500	13	$1,500
Subtotal		*$641,000*		*$643,500*		*$643,500*
Balranald-Tooleybuc Road	1	$61,000	1	$62,000	1	$62,000
	2	$5,320,000	3	$7,025,000	3	$7,025,000
	6	$480,000	6	$480,000	6	$480,000
	10	$39,000	10	$39,000	10	$39,000
	13	$500	13	$500	13	$500
	14	$149,000	14	$149,000	14	$149,000
Subtotal		*$6,049,500*		*$7,755,500*		*$7,755,500*
Total		**$8,171,000**		**$10,275,000**		**$10,348,500**

Notes: *1. Aurecon (2015) based on 2014 road work costs.*

Table 6.8 Estimated pavement base and HML haulage maintenance costs (Scenarios 3 and 4)

Road section	Base case		Scenario 3 minimum haulage with HML axle loadings		Scenario 4 maximum haulage with HML axle loadings	
	Treat ment type	Cost	Treat ment type	Cost	Treat ment type	Cost
Balranald-Ivanhoe Road	1	$81,000	1	$82,000	1	$82,000
	2	$1,028,000	3	$1,410,000	3	$1,410,000
	5	$65,000	6	$72,000	6	$72,000
	9	$25,000	10	$30,000	10	$30,000
	13	$1,000	13	$1,500	13	$1,500
	14	$27,000	14	$27,000	14	$27,000
Subtotal		*$1,227,000*		*$1,622,500*		*$1,622,500*
McCabe Street	1	$15,000	1	$16,000	1	$16,000
	2	$205,000	2	$277,000	3	$277,000
	13	$500	13	$1,000	13	$1,000
	14	$33,000	14	$33,000	14	$33,000
Subtotal		*$253,500*		*$327,000*		*$327,000*

Table 6.8 Estimated pavement base and HML haulage maintenance costs (Scenarios 3 and 4)

Road section	Base case		Scenario 3 minimum haulage with HML axle loadings		Scenario 4 maximum haulage with HML axle loadings	
	Treat ment type	Cost	Treat ment type	Cost	Treat ment type	Cost
Sturt Highway	1	$6,000	1	$7,000	1	$7,000
	4	$620,000	4	$620,000	4	$620,000
	6	$13,000	7	$14,000	8	$15,500
	10	$1,000	11	$1,000	11	$1,000
	12	$1,000	13	$1,500	13	$1,500
Subtotal		*$641,000*		*$643,500*		*$645,000*
Balranald-Tooleybuc Road	1	$61,000	1	$62,000	1	$62,000
	2	$5,320,000	3	$7,025,000	3	$7,025,000
	6	$480,000	6	$480,000	6	$480,000
	10	$39,000	10	$39,000	10	$39,000
	13	$500	13	$500	13	$500
	14	$149,000	14	$149,000	14	$149,000
Subtotal		*$6,049,500*		*$7,755,500*		*$7,755,500*
Total		**$8,171,000**		**$10,348,500**		**$10,350,000**

Notes: 1. Aurecon (2015) based on 2014 road work costs.

The estimated additional pavement maintenance costs from the haulage of HMC and ilmenite (and gravel by back loading) for each product transport scenario are summarised in Table 6.9.

Table 6.9 Summary of additional pavement maintenance cost by route section

Road section	Incremental pavement maintenance cost			
(Road authority)	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**
Balranald-Ivanhoe Road (BSC)	$395,500	$395,500	$395,500	$395,500
McCabe Street (BSC)	$0	$73,500	$73,500	$73,500
Sturt Highway (RMS)	$2,500	$2,500	$2,500	$4,000
Balranald-Tooleybuc Road (RMS)	$1,706,000	$1,706,000	$1,706,000	$1,706,000
Total	**$2,104,000**	**$2,177,500**	**$2,177,500**	**$2,179,000**

Notes: 1. Aurecon (2015) based on 2014 road work costs.

6.5.3 Balranald Shire Council roads

Iluka propose to negotiate an equitable annual road maintenance contribution with BSC based on a dollar per tonne formula for the two northern sections of the haulage route (Balranald-Ivanhoe Road and McCabe Street. This would be undertaken on a similar basis to the annual road maintenance contributions which have been agreed with BSC for the Atlas Campaspe Mineral Sands Project.

i Project area access routes

This sections of Burke and Wills Road and Arumpo Road incorporated into the Nepean access road would be used for various Balranald Project construction and operational activities, including the proposed ore transport operation between the West Balranald and Nepean mines (Year 6 to Year 8).

As outlined in Section 6.5.1, these sections would be upgraded to a 'haul road' standard which would provide a two wide lane unsealed gravel road surface. The road surfaces would be maintained by grading to prevent the development of corrugations, potholes and other surface defects which could potentially affect the route ride-ability and safety for all road users.

ii Balranald-Ivanhoe Road and Balranald township

For sections of Balranald-Ivanhoe Road and McCabe Street which are part of the product haulage route, the detailed visual pavement condition assessment (Aurecon 2015) logged defects by type, severity and location using Austroads guidelines). This work was used by Aurecon to determine the future Balranald Project life maintenance costs for these roads which are summarised, in Table 6.6, Table 6.7, Table 6.8 and Table 6.9.

The costing has estimated the additional future road pavement maintenance requirement (at 2014 roadwork costs) over the operational life of the Balranald Project, as an additional $395,500 for Balranald-Ivanhoe Road and an additional $73,500 (except for the GML minimum haulage - Scenario 1) for McCabe Street.

Discussions are continuing between Iluka and BSC to determine the appropriate $ per tonne pavement maintenance contribution for these two roads over the life of the Balranald Project.

The agreement by Iluka would include formal commitment by the road authority to spend the additional Iluka road maintenance contribution on maintaining these two roads.

6.5.4 Roads and Maritime Services roads

The Sturt Highway and Balranald-Tooleybuc Road (Mallee Highway) are state funded roads which carry substantial volumes of long distance and interstate freight traffic. The proposed mine product haulage operational traffic will result in some additional route maintenance costs for these roads. However this activity should be considered part of the normal traffic using these routes under approved mass limits.

i Balranald to Tooleybuc

For sections of the Sturt Highway and Balranald Tooleybuc Road which are part of the product haulage route, the detailed visual pavement condition assessment (Aurecon 2015) logged defects by type, severity and location using Austroads guidelines). This work was used by Aurecon to determine the future Balranald Project life maintenance costs for these roads, which are summarised, in Table 6.6, Table 6.7, Table 6.8 and Table 6.9.

As the Sturt Highway and Balranald-Tooleybuc Road (Mallee Highway) are state funded roads which carry substantial volumes of long distance and interstate freight traffic, the proposed mine product haulage operations using these roads, should be considered part of their normal traffic usage.

Also, as these roads are state funded roads, the relevant road authority should retain overall responsibility for sourcing an appropriate maintenance budget to maintain road pavement standards on these roads, based on NSW and Commonwealth government revenues sourced from heavy vehicle registration charges, fuel excise and other sources (eg mining royalties).

6.6 Car parking

Balranald Project operational phase car parking areas would be provided to meet demand at all identified project worksites and at the accommodation facility.

6.7 Public transport

No mine access public transport is required for the Balranald Project operational phase. Extensive use of shuttle bus transport is envisaged for project operational workforce travel between the accommodation facility and project operational worksites, plus a daily shuttle bus service to and from the regional airport at Mildura for FIFO workers.

These shuttle buses would primarily travel via the West Balranald access road (which would be a private road) to and from the main pit and processing areas.

6.8 Pedestrian and cyclist access

Due to the remoteness of the Balranald Project operational phase work areas, access by the workforce using either cycling or walking is not envisaged.

7 Mitigation measures

7.1 Road and intersection improvements

7.1.1 Improvements to be implemented by Iluka

Proposed road and intersection improvements that will be implemented by Iluka to mitigate the impacts of Balranald Project-related traffic are provided in Table 7.1.

Table 7.1 Summary of proposed road and intersection improvements

Item	Location	Balranald Project phase	Existing road width and condition	Proposed improvement
1	Burke and Wills Road	Construction	Typically unsealed two lanes wide for the initial 22 km from Balranald-Ivanhoe Road, reducing to single lane width over the remaining 24 km to Arumpo Road	Prior to the establishment of the West Balranald access road Iluka may require temporary access for traffic during the early stages of construction. Iluka would ensure a minimum 8 m wide two lane unsealed road is provided on all sections required for any Balranald Project construction access with sections regraded to address induced damage and minimise corrugations, potholes and other surface defects.
2	Burke and Wills Road	Operational	Typically unsealed two lanes wide for the initial 22 km from Balranald-Ivanhoe Road, reducing to single lane width over the remaining 24 km to Arumpo Road	Approximately 12 km of the northern section of Burke and Wills Road would form part of the Nepean access road. This section would be used by Balranald Project ore transport trucks travelling between the two mines in Year 6 to Year 8. This section would be improved by Iluka prior to the start of Nepean mine operations to a minimum width of 11 m, but would remain unsealed. This would be consistent with an 8 m sealed width (formation width of 11 m including 1.5 m wide shoulders) recommended by Austroads for a road permanently carrying the proposed Balranald Project ore transport volumes. Sealing the road is not proposed given the short Nepean mine operation phase. Iluka would install signage east of the Nepean access road intersection with Burke and Wills Road (34 km north west of Balranald-Ivanhoe Road) and south of Arumpo Road at the Burke and Wills Road intersection alerting road users to the presence of ore transport trucks. This section would be regraded during the Balranald Project operational phase to minimise corrugations, potholes and other surface defects. Alternatively, the unsealed road width could be reduced to 8 m with the implementation of additional traffic management measures. This would involve clearly signposting the alternative (mainly sealed) travel route via Arumpo Road (see Item 3), for Lake Mungo tourist traffic and other non-local traffic. The speed limit could be reduced to 80 km/hr in consultation with BSC to minimise potential traffic safety conflicts between operational phase traffic and other non-mining traffic using the road.

Table 7.1 Summary of proposed road and intersection improvements

Item	Location	Balranald Project phase	Existing road width and condition	Proposed improvement
3	Arumpo Road	Operational	Typically unsealed, except for a 3 km section near Balranald-Ivanhoe Road	Only occasional Balranald Project traffic usage is anticipated during the construction phase and no improvements are required during this phase. Approximately 10 km of Arumpo Road west of the Burke and Wills Road intersection would from part of the Nepean access road. This section would be improved by Iluka prior to the start of Nepean mine operations to be a minimum of 11 m wide but would remain unsealed. This would be consistent with an 8 m sealed width (formation width of 11 m including 1.5 m wide shoulders) recommended by Austroads for a road permanently carrying the proposed Balranald Project ore transport volumes. Sealing the road is not proposed given the short Nepean mine operation phase. Iluka would install signage west of the actual Nepean mine access intersection (10 km north west of Burke and Wills Road) and east of the Burke and Wills Road intersection alerting road users to the presence of ore transport trucks. This section would be regraded during the Balranald Project operational phase to minimise corrugations, potholes and other surface defects. Advance and intersection direction signage would be provided by Iluka at the Arumpo Road/Burke and Wills Road intersection for traffic approaching from the west (ie from the Lake Mungo direction). This would advise tourist traffic travelling towards Balranald to travel via Arumpo Road rather than Burke and Wills Road. It would indicate that, if travelling to Balranald, there is 10 km of unsealed road on Arumpo Road and 46 km of unsealed road on Burke and Wills Road.
4	Balranald-Ivanhoe Road	Construction and operational	Typically 7 m sealed width, with no edge lines or sealed shoulders, on the sections south of the Burke and Wills Road intersection	Seal widening is not required. Route signage, line marking and guide post deficiencies identified in the RSA would be rectified by Iluka during the construction phase. Existing localised road pavement defects identified in the Road Pavement Strength Review would be addressed by BSC prior to the commencement of construction phase for the Balranald Project. A pavement maintenance contribution to BSC (based on tonnes of product transported) would be negotiated prior to the Balranald Project operational phase. This would be used by BSC for maintenance of this section of road during product haulage.

Table 7.1 Summary of proposed road and intersection improvements

Item	Location	Balranald Project phase	Existing road width and condition	Proposed improvement
5	McCabe Street	Construction and operational	Typically 6 to 7 m sealed width, no sealed shoulders	It is understood McCabe Street was constructed in 2005, resealed in 2010 and based upon a five year maintenance program is half way through its design life. Existing requirement to resurface asphalt layer identified in the Road Pavement Strength Review would be addressed by Iluka directly or through road maintenance contributions to BSC in the Balranald Project operations phase. Undertaking asphalt upgrade would reduce ongoing pavement maintenance contribution to BSC (based on tonnes of product transported) along McCabe Street.
6	Balranald-Ivanhoe Road and West Balranald access road intersection	Construction and operational	No intersection currently	A new Balranald-Ivanhoe Road/West Balranald access road intersection, designed in accordance with the Austroads intersection design standard, would be constructed by Iluka. It would incorporate a left turn deceleration lane to facilitate heavy vehicle movements (primarily to and from the south) at the intersection. The intersection sight distance would be a minimum of 450 m in both directions along Balranald-Ivanhoe Road. Advance and position intersection signs would be provided for the approaching traffic on Balranald-Ivanhoe Road in both directions. As the intersection sight distance visibility meets Austroads standards and additional intersection improvement measures such as lighting would not be required.
7	Balranald-Ivanhoe Road and Moa Street intersection	Construction	Both roads sealed with no additional lanes	Oversize vehicles would be travelling through this intersection on a regular basis during the Balranald Project construction phase. Traffic management and additional intersection earthworks (eg fill) would be provided by Iluka to accommodate the turning 'swept paths' for these vehicles as determined by Aurecon's (2012) assessment for oversize vehicle paths. This temporary improvement would also facilitate the use of this intersection by other Balranald Project-related construction, including B-Double type trucks.
8	Balranald town local roads, Moa Street, O'Connor Street and Piper Street	Construction and operational	Sealed local roads	With the exception of oversize vehicles which would need to travel via Piper, O'Connor and Moa Streets, Iluka would seek to direct all other project heavy vehicle traffic travelling to and from the west of Balranald, to travel via McCabe Street and the Sturt Highway route (Market Street) when travelling through Balranald, to minimise potential traffic impacts to residential areas.
9	Moa Street and O'Connor Street intersection	Construction	Both roads sealed with no additional lanes	Improvement as for Item 7.

Table 7.1 Summary of proposed road and intersection improvements

Item	Location	Balranald Project phase	Existing road width and condition	Proposed improvement
10	Piper Street and O'Connor Street intersection	Construction	Both roads sealed with no additional lanes	Improvement as for Item 7.
11	Sturt Highway and Piper Street intersection	Construction	Urban T-intersection	Improvement as for Item 7.
12	Sturt Highway and Murray Valley Highway intersection near Euston/ Robinvale	Construction	Both roads sealed with no additional lanes	Oversize vehicles would be travelling through this intersection on a regular basis for several months during the Balranald Project construction phase. Traffic management and additional intersection earthworks (eg fill) would be provided by Iluka to accommodate the turning 'swept paths' for these vehicles as determined by Aurecon's (2012) assessment for oversize vehicle paths. This temporary improvement would also facilitate the use of this intersection by other Balranald Project-related construction traffic, including B-Double type trucks.
13	Balranald-Ivanhoe Road and McCabe Street intersection	Operational	Additional Type AUL left turning lane with no line-marking	Iluka would formalise the existing left turn deceleration lane, designed in accordance with the Austroads intersection design standard, by providing line marking for the lane prior to the start of the Balranald Project operational phase. Visual barriers and/or landscaping would be provided by Iluka prior to the start of the Balranald Project operational phase to remove the RSA identified 'see through effect' between the Balranald Road (north) and McCabe Street approaches. The provision of a northbound right turn deceleration lane on Balranald Road is not warranted as there are currently low traffic volumes turning right from this direction and these volumes would not increase due to the Balranald Project.
14	McCabe Street and Sturt Highway intersection	Operational	Urban four way intersection	Signage and/or vegetation within the road reserve of the Sturt Highway currently blocks sight lines of approaching traffic on the Sturt Highway at the McCabe Street and Sturt Highway intersection. Iluka, in consultation with RMS, would rectify by vegetation removal and adjustments to the height of signage, to provide clear sight lines for car and truck drivers who are travelling on the McCabe Street (north) and Sturt Highway (south) approaches to the intersection.
15	Arumpo Road and Burke and Wills Road intersection	Operational	Both roads unsealed	Iluka would seal the three intersection approaches, for at least 100 m on the two Arumpo Road approaches and at least 50 m on the Burke and Wills Road approach. This would improve the intersection traffic operations, visibility (by reducing dust at intersection location) and traffic safety during the operation of the Nepean mine.

7.1.2 Improvements to be implemented by road authorities

It has been identified that short - term road and intersection improvements would be required, either currently or by the years 2018 or 2020, at several locations either due to existing road construction or safety defects or projected traffic growth, in the absence of the Balranald Project. These road improvements are summarised in Table 7.2. It is envisaged that these improvements would generally be implemented by the responsible road authority for each route.

Table 7.2 Related road and intersection improvements by road authorities

Item	Location	Existing road width and condition	Road or intersection improvement
1	Moa Street, north of O'Connor Street	Typically 6 m sealed width with no edge lines or sealed shoulders	Background traffic growth on this road, even in the absence of the Balranald Project traffic, would mean that a 7 m wide sealed road would be required by 2018, ie prior to the start of the main Balranald Project construction phase.
2	Balranald-Tooleybuc Road (Mallee Highway)	Typically a minimum of 7 m sealed width with sealed edge lines and narrow sealed shoulders.	Existing route deficiencies, relating to signage and guide posts and existing localised road pavement defects are being addressed by RMS. These should be completed prior to the Balranald Project operational phase. The road is a state funded highway which carries substantial volumes of long distance and interstate freight traffic. As such, the proposed mine product haulage operations using this road should be considered part of the normal traffic use.
3	Sturt Highway and Balranald Tooleybuc Road intersection	Austroads Type AUR/AUL intersection	The existing intersection has an Austroads Type AUR/AUL left and right turn treatment which is no longer recommended by Austroads. The current intersection could be changed to the Austroads recommended Type CHR/CHL intersection treatment by changing line markings. The intersection would not be significantly impacted by Balranald Project construction phase traffic. The intersection is on the product haulage route and would be used extensively during the Balranald Project operational phase. However, it has been assumed any intersection improvement works would be implemented by RMS in advance of the Balranald product haulage operation commencing.
4	Existing Tooleybuc Bridge (east side)	Conflicting signage	The RSA recommended that the existing signage at the east end of the existing Tooleybuc Bridge (intersection with Murray Street) be reviewed. Conflicting signage should be removed, additional advance intersection signage installed, give way signs should be installed, and appropriate hold lines marked on the road pavement provided. Give way signage is also required on the western bridge approach as traffic from either direction cannot proceed onto the bridge, if there is already a vehicle travelling in the opposite direction on the bridge. It has been assumed the intersection improvement works would be implemented by RMS in advance of the Balranald product haulage operation commencing, unless the Tooleybuc Bridge itself is replaced by RMS during this timeframe.

7.2 Traffic management plan

Traffic management plans would be prepared for the Balranald Project construction and operational phases. The traffic management plans would address the Balranald Project approval conditions and would describe measures to:

- maximise safety for all light and heavy vehicle operations related to the Balranald Project;
- ensure compliance with the state and Commonwealth road transport legislative and regulatory requirements;
- manage driver fatigue; and
- respond to any product haulage incident or emergency.

8 Conclusion

The proposed road and intersection improvements in Table 7.1 would address all of the identified traffic safety, level of service, road pavement and maintenance impacts from the Balranald Project traffic during the construction and operational phases. This would include negotiating equitable road maintenance agreements with the BSC to proportionally fund the ongoing road maintenance requirements for the Council roads affected along the product haulage route during operations.

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Appendix A

Typical Road Width Sections

Balranald Project road cross sections and condition assessment

Arumpo Road 23 km west of Balranald-Ivanhoe Road looking west (near Nepean mine entry)

Arumpo Road 6 km west of Balranald-Ivanhoe Road looking east

Arumpo Road 2km west of Balranald-Ivanhoe Road looking east

Burke and Wills Road 38 km north west of Balranald-Ivanhoe Road looking north west

Burke and Wills Road 14 km north west of Balranald-Ivanhoe Road looking north west

Balranald-Ivanhoe Road 50 km north of Balranald looking south

Balranald-Ivanhoe Road 40 km north of Balranald looking south

Balranald-Ivanhoe Road 30 km north of Balranald looking south

Balranald-Ivanhoe Road 20 km north of Balranald looking south

Balranald-Ivanhoe Road 10 km north of Balranald looking south

McCabe Street near River Street looking south

McCabe Street near Island Road looking south

Sturt Highway 1 km south of Balranald looking north

Balranald Tooleybuc Road Road 45 km north of Tooleybuc looking south

Balranald Tooleybuc Road 35 km north of Tooleybuc looking south

Balranald Tooleybuc Road 25 km north of Tooleybuc looking south

Balranald Tooleybuc Road 15 km north of Tooleybuc looking south

Balranald Tooleybuc Road 5 km north of Tooleybuc looking south

Balranald Tooleybuc Road at Tooleybuc urban area looking north

At Tooleybuc bridge looking west

At Tooleybuc Bridge looking east

Sturt Highway (Market Street) at Balranald looking east

Sturt Highway (Market Street) at Balranald looking west

Sturt Highway 10 km west of Balranald looking west

Sturt Highway 20 km west of Balranald looking west

Sturt Highway 30 km west of Balranald looking west

Sturt Highway 40 km west of Balranald looking west

Sturt Highway 50 km west of Balranald looking west

Sturt Highway 60 km west of Balranald looking west

Sturt Highway 70 km west of Balranald looking west

Appendix B

RMS Traffic Volume Data

Traffic Volume Data for South West Region 2006

S	STATION	ROAD	LOCATION	MAP	1997 AADT	2000 AADT	2003 AADT	< 2005 Flag	2006 AADT	2006 Flag
	95.276	MR371	AT CARRATHOOL SHIRE BDY	44	117	145	185	Axle Pair	120	Vehicle
	95.255	MR80	AT CARRATHOOL SHIRE BDY	44	882	996	1059	Axle Pair	870	Vehicle
	97.103	COBB HWY,SH21	AT CENTRAL DARLING SHIRE BDY	34	55	92	67	Axle Pair	48	Vehicle
	97.102	MR80	AT CENTRAL DARLING SHIRE BDY	34	--	--		Axle Pair		
	95.301	MR240	AT COOLAMON SHIRE BDY	52	1441	1530	1548	Axle Pair	1511	Vehicle
	95.396	OLYMPIC WAY,MR78	AT COOTAMUNDRA/JUNEE SHIRE BDY	52	--	--		Axle Pair		
	97.473	DAYSDALE-BERRIGAN RD	AT COROWA SHIRE BDY	57	--	--		Axle Pair		
	97.474	RIVERINA HWY,SH20	AT COROWA SHIRE BDY	57	--	--		Axle Pair		
	94.222	MR56	AT COWRA SHIRE BDY	45	1266	1200	1479	Axle Pair	994	Vehicle
	95.306	MR243	AT GUNDAGAI SHIRE BDY	52	203	181	256	Axle Pair	211	Vehicle
	95.479	MR279	AT GUNDAGAI SHIRE BDY	52	--	--		Axle Pair		
	95.478	MR280	AT GUNDAGAI SHIRE BDY	52	259	272	378	Axle Pair	250	Vehicle
	95.476	SNOWY MOUNTAINS HWY,SH4	AT GUNDAGAI SHIRE BDY	52	--	--		Axle Pair		
	95.027	HUME HWY,SH2	AT GUNDAGAI/WAGGA WAGGA BDY	52	10649	11663	12966	Axle Pair	7857	Vehicle
	97.234	COBB HWY,SH21	AT HAY SHIRE BDY	51	425	505	459	Axle Pair	227	Vehicle
	97.130	MID WESTERN HWY,SH6	AT HAY SHIRE BOUNDARY	44	670	792	807	Axle Pair	405	Vehicle
	95.341	MR323	AT JERILDERIE SHIRE BDY	57	--	--		Axle Pair		
	95.346	MR356	AT JERILDERIE SHIRE BDY	57	--	--		Axle Pair		
	95.216	MR59	AT JERILDERIE SHIRE BDY	51	--	--		Axle Pair		
	95.332	NEWELL HWY,SH17	AT JERILDERIE SHIRE BDY	51	2017	1717	1819	Axle Pair		Axle Pair
	95.316	WAGGA WAGGA-NANGUS RD	AT JUNEE SHIRE BDY	52	--	--		Axle Pair		
	95.287	MR231	AT LACHLAN SHIRE BDY	44	--	--		Axle Pair		
	95.274	MR371	AT LACHLAN SHIRE BDY	44	--	--		Axle Pair		
	95.308	MR80	AT LEETON SHIRE BDY	51	2728	3145	3535	Axle Pair	2604	Vehicle
	95.338	MR370	AT LOCKHART-CULCAIRN SHIRE BDY	57	331	309	390	Axle Pair	307	Vehicle
	95.689	GRIFFITH-LEARMONTH WELL	AT MIRROOL CREEK BR	44	--	--		Axle Pair		
	97.226	COUNCIL ROAD	AT MURRAY SHIRE BDY-N OF MR94	56	--	--		Axle Pair		
	95.021	STURT HWY,SH14	AT MURRUMBIDGEE SHIRE BDY	51	1635	1617	1651	Axle Pair	857	Vehicle
	95.654	NEWELL HWY,SH17	AT RLY OVBR 3KM S OF MORUNDAH	51	--	--		Axle Pair		
	95.848	BELLS RD,MR78	AT RLY XING,5KM S OF GEROGERY	57	--	--	2821	Axle Pair	2437	Vehicle
	94.083	MR56	AT RLY XING,N OF SH2,HUME HWY	53	--	--		Axle Pair		
	95.269	MR241	AT TEMORA/YOUNG SHIRE BDY	45	366	386	466	Axle Pair	410	Vehicle
	95.395	BURLEY GRIFFIN WAY,MR84	AT TEMORA-COOTAMUNDRA SHIRE BDY	52	1076	1012	1177	Axle Pair	845	Vehicle
	97.471	MR323	AT URANA SHIRE BDY	57	--	--		Axle Pair		
	97.472	MR356	AT URANA SHIRE BDY	57	361	387	412	Axle Pair		Axle Pair
	97.470	MR59	AT URANA SHIRE BDY	51	--	--		Axle Pair		
	97.216	MR319	AT WAKOOL RIVER BR	56	599	659	639	Axle Pair	515	Vehicle
	97.482	MR67	BALRANALD-5KM N OF SH14,STURT HWY	50	320	448	396	Axle Pair	259	Vehicle

Traffic Volume Data for
South West Region 2006

S	STATION	ROAD	LOCATION	MAP	1997 AADT	2000 AADT	2003 AADT	< 2005 Flag	2006 AADT	2006 Flag
	97.481	STURT HWY,SH14	BALRANALD-8KM W OF MR67,MAYALL ST	50	--	--		Axle Pair		
	97.487	STURT HWY,SH14	BALRANALD-E OF MR67,KYALITE RD	TOWN	1865	2053	2165	Axle Pair	969	Vehicle
	97.483	MARKET ST,SH14	BALRANALD-N OF MAYALL ST	TOWN	--	--		Axle Pair		
	97.480	MR67	BALRANALD-N OF MR514,OXLEY RD	50	77	106	67	Axle Pair	50	Vehicle
	97.486	STURT HWY,SH14	BALRANALD-N OF MR67,KYALITE RD	TOWN	--	--	2674	Axle Pair		Axle Pair
	97.484	MAYALL ST,MR67	BALRANALD-N OF SH14,MARKET ST	TOWN	--	--		Axle Pair		
	97.485	MARKET ST,SH14	BALRANALD-S OF MAYALL ST	TOWN	3314	3737	4003	Axle Pair	3381	Axle Pair
*	97.488	KYALITE RD,MR67	BALRANALD-S OF SH14,STURT HWY	TOWN	888	928	962	Axle Pair	929	Axle Pair
*	95.302	BURLEY GRIFFIN WAY,MR84	BARELLAN-1.5K W OF NARRANDERA RD	44	1154	1245	1338	Axle Pair	1337	Axle Pair
	97.218	MR319	BARHAM-AT MURRAY RIVER BR	56	4118	5024		Axle Pair	3857	Vehicle
	97.219	MR341	BARHAM-E OF MR319,BARHAM RD	56	568	567	610	Axle Pair	366	Vehicle
*	97.220	MR319	BARHAM-S OF MR341,MOAMA RD	56	1153	1614	1325	Axle Pair	1238	Axle Pair
	97.002	MR391	BARMAH-AT MURRAY RIVER BR	56	781	1062	1069	Axle Pair	763	Vehicle
	95.152	MR398	BARMEDMAN-3.2KM E OF MR57,TEMORA RD	45	--	--		Axle Pair		
	95.379	MR398	BARMEDMAN-4.8KM S OF MR57,TEMORA RD	45	141	88	79	Axle Pair	100	Vehicle
	95.151	MR57	BARMEDMAN-AT RLY XING	45	1362	1538	1566	Axle Pair	1048	Vehicle
	95.150	MR57,TEMORA RD	BARMEDMAN-N OF MR398,GRENFELL RD	45	--	--		Axle Pair		
	97.038	COBB HWY,SH21	BARNES-AT RLY XING	56	--	--		Axle Pair		
	97.039	COBB HWY,SH21	BARNES-N OF MR391,BARMAH RD	56	2083	2241	2347	Axle Pair	1707	Vehicle
	97.272	MR226	BAROOGA-AT MURRAY RIVER BR	56	5323	--	5670	Axle Pair	5885	Vehicle
	97.274	MR550	BAROOGA-E OF COBRAM RD	56	--	--		Axle Pair		
	97.276	MR363	BAROOGA-N OF MR550,TOCUMWAL RD	56	1095	1189	1011	Axle Pair	825	Vehicle
	97.277	MR550	BAROOGA-W OF MR363,BERRIGAN RD	56	432	615	480	Axle Pair	518	Vehicle
	97.273	COUNCIL RD-NR VIC BORDER	BAROOGA-W OF MR550,COROWA RD	56	617	736	654	Axle Pair	605	Vehicle
*	95.191	BATLOW RD,MR85	BATLOW-6.4KM N OF P.O.	57	1061	1040	1188	Axle Pair	1220	Axle Pair
	95.491	MR85	BATLOW-N OF YAVEN YAVEN CK RD	57	--	--		Axle Pair		
	95.496	MR85	BATLOW-S OF YAVEN YAVEN CK RD	57	--	--		Axle Pair		
	95.497	COUNCIL ROAD	BATLOW-W OF MR85,TUMBARUMBA RD	57	--	--		Axle Pair		
	95.204	MR59	BELFRAYDEN-AT RLY XING	52	893	1329	1081	Axle Pair	793	Vehicle
	97.215	MR319	BEREMEGAD TANK-N OF WAKOOL RD	50	236	291	297	Axle Pair	217	Vehicle
	97.359	JERILDERIE ST,MR564	BERRIGAN-AT RLY XING	TOWN	1027	944	946	Axle Pair		Axle Pair
	97.371	CARTER ST,MR356	BERRIGAN-E OF SH20,JERILDERIE ST	TOWN	--	--		Axle Pair		
	97.360	JERILDERIE ST,MR564	BERRIGAN-N OF SH20,CHANTER ST	TOWN	--	--		Axle Pair		
	97.309	JERILDERIE ST,SH20	BERRIGAN-S OF MR356,CARTER ST	TOWN	--	--		Axle Pair		
	97.466	RIVERINA HWY,SH20	BERRIGAN-S OF MR363,BAROOGA RD	56	1438	710	736	Axle Pair	524	Vehicle
	97.308	RIVERINA HWY,SH20	BERRIGAN-S OF OSBORNE ST	TOWN	--	--		Axle Pair		
	97.312	CHANTER ST,SH20	BERRIGAN-W OF DIBBS ST	TOWN	1066	943	1011	Axle Pair		Axle Pair
	97.310	CHANTER ST,SH20	BERRIGAN-W OF MR564,JERILDERIE ST	TOWN	2792	2541	2814	Axle Pair		Axle Pair

Traffic Volume Data for South West Region 2006

S	STATION	ROAD	LOCATION	MAP	1997 AADT	2000 AADT	2003 AADT	< 2005 Flag	2006 AADT	2006 Flag
	94.513	BURLEY GRIFFIN WAY,MR84	EAST OF NUBBA RD	52	--	--		Axle Pair		
	94.026	YASS VALLEY WAY,RR7610	EAST OF SH15,BARTON HWY	53	--	--		Axle Pair	887	Axle Pair
	97.077	MR94	EAST OF THE BRASSI ROAD	56	--	--		Axle Pair		
	95.455	OLD OLYMPIC WAY	ETTAMOGAH-AT BOWNA CREEK BR	57	--	--		Axle Pair		
	95.038	HUME HWY,SH2	ETTAMOGAH-N OF RD TO GEROGERY(OLD78)	57	12402	12914	14128	Axle Pair	8578	Vehicle
	95.133	OLD OLYMPIC WAY	ETTAMOGAH-N OF SH2,HUME HWY	57	1179	1622	1211	Axle Pair	1204	Vehicle
	95.039	HUME HWY,SH2	ETTAMOGAH-S OF RD TO GEROGERY(OLD78)	57	--	--		Axle Pair	10499	Vehicle
	97.489	STURT HWY,SH14	EUSTON-2KM S OF MR583	50	4115	4473	4354	Axle Pair	4383	Axle Pair
	97.477	MR583	EUSTON-AT NSW-VICTORIAN BORDER	50	3243	3230	3213	Axle Pair	3152	Vehicle
	97.476	STURT HWY,SH14	EUSTON-E OF MR583,MURRAY RIVER BR RD	50	1882	2074	2181	Axle Pair	1215	Vehicle
	97.478	STURT HWY,SH14	EUSTON-W OF MR583,MURRAY RIVER BR RD	50	--	--		Axle Pair		
*	97.028	MURRAY ST,SH17	FINLEY-1.6K S OF SH20 TO BERRIGAN	TOWN	4043	4456	4506	Axle Pair	4196	Axle Pair
	97.313	BERRIGAN RD,SH20	FINLEY-E OF HOWE ST	TOWN	1232	1167	1293	Axle Pair	1001	Vehicle
	97.314	BERRIGAN RD,SH20	FINLEY-E OF SH17,MURRAY ST	TOWN	--	--		Axle Pair		
	97.031	NEWELL HWY,SH17	FINLEY-N OF MULWALA CANAL BR	TOWN	3532	3539	3362	Axle Pair	1984	Vehicle
	97.298	JERILDERIE RD,SH17	FINLEY-N OF SH20,TUPPAL ST	TOWN	--	--		Axle Pair		
	97.300	MURRAY ST,SH17	FINLEY-S OF SH20,BERRIGAN RD	TOWN	--	--		Axle Pair		
	97.299	MURRAY ST,SH17	FINLEY-S OF SH20,TUPPAL ST	TOWN	--	--		Axle Pair		
	97.024	DENILIQUIN RD,SH20	FINLEY-W OF HAMILTON ST	TOWN	1812	1675	1851	Axle Pair	1313	Vehicle
	97.315	TUPPAL ST,SH20	FINLEY-W OF SH17,MURRAY ST	TOWN	--	--		Axle Pair		
	95.060	STURT HWY,SH14	FOREST HILL-1KM E OF ALLONBY AVE	52	5867	5589	5890	Axle Pair	4662	Vehicle
	95.174	STURT HWY,SH14	FOREST HILL-1KM W OF ALLONBY AVE	52	6900	8528	7508	Axle Pair	7657	Vehicle
	95.383	GAROOLGAN-TALEEBAN RD	GAROOLGAN-N OF MR84 TO GRIFFITH	44	--	--		Axle Pair		
	95.456	OLYMPIC WAY,MR78	GEROGERY-0.8KM N OF P.O.	57	2930	3206	3172	Axle Pair	2555	Vehicle
	95.105	SNOWY MOUNTAINS HWY,SH4	GILMORE-N OF MR85,TUMBARUMBA RD	52	3287	4502	4452	Axle Pair	3775	Axle Pair
	95.107	MR85	GILMORE-S OF SH4,SNOWY MOUNTAINS HWY	52	--	--	1568	Axle Pair	1337	Vehicle
	95.108	SNOWY MOUNTAINS HWY,SH4	GILMORE-W OF MR85,TUMBARUMBA RD	52	2113	2045	2497	Axle Pair	1935	Vehicle
	95.373	WEST WYALONG RD,MR57	GIRRAL-S OF MR231,UNGARIE RD	44	508	505	525	Axle Pair	444	Vehicle
	95.224	MR231	GIRRAL-W OF MR57,WEST WYALONG RD	44	370	391	388	Axle Pair	316	Vehicle
	97.136	MID WESTERN HWY,SH6	GOOLGOWI-E OF MR80,MERRIWAGGA RD	44	--	--		Axle Pair		
	97.135	MR80	GOOLGOWI-N OF SH6,MID WESTERN HWY	44	629	692	732	Axle Pair	510	Vehicle
	97.134	MR80	GOOLGOWI-S OF SH6,MID WESTERN HWY	44	--	--		Axle Pair		
	97.133	MID WESTERN HWY,SH6	GOOLGOWI-W OF MR80,MERRIWAGGA RD	44	655	903	861	Axle Pair	454	Vehicle
	95.809	WELLUMBA CREEK RD	GREG GREG-E OF MR628,TOOMA-KHANC' RD	57	--	--		Axle Pair		
	95.808	BRUNGEN'-TUMB'A,MR628	GREG GREG-W OF GREG GREG-TOOMA RD	57	--	--		Axle Pair		
	95.311	BOORGA RD	GRIFFITH-1.6KM N OF NEW FARMS RD	44	--	--		Axle Pair		
	95.147	SCENIC DR	GRIFFITH-2KM E OF BOONAH ST	TOWN	--	--		Axle Pair		
	95.253	CROSSING ST,MR321	GRIFFITH-AT RLY XING	TOWN	--	--		Axle Pair		

Traffic Volume Data for South West Region 2006

S	STATION	ROAD	LOCATION	MAP	1997 AADT	2000 AADT	2003 AADT	< 2005 Flag	2006 AADT	2006 Flag
	97.209	MR222	TOOLEYBUC-AT MURRAY RIVER BR	50	1495	1919	1543	Axle Pair	1140	Vehicle
	97.184	MR319	TOONGIMBIE TANK-N OF SH14,STURT HWY	50	--	--		Axle Pair		
	97.192	MR319	TOONGIMBIE TANK-S OF SH14,STURT HWY	50	90	82	96	Axle Pair	71	Vehicle
	95.506	MR85	TUMBARUMBA-8KM N OF MR628	57	531	605	709	Axle Pair	556	Vehicle
	95.507	BRUNG'-TUMB'A RD,MR628	TUMBARUMBA-8KM S OF MR85,ALBURY ST	57	398	403	413	Axle Pair		Axle Pair
	95.196	MR85	TUMBARUMBA-AT RLY XING	57	--	--		Axle Pair		
	95.193	WILLIAM ST,MR628	TUMBARUMBA-N OF BYATT ST	TOWN	--	--		Axle Pair		
	95.572	THE PARADE,MR85	TUMBARUMBA-N OF MR85,ALBURY ST	TOWN	3213	3241	3181	Axle Pair	3095	Axle Pair
	95.195	MR284	TUMBARUMBA-N OF MR85,TUMBARUMBA RD	57	720	810	854	Axle Pair	707	Vehicle
	95.192	TUMUT RD,MR85	TUMBARUMBA-S OF BOGONG ST	TOWN	--	--		Axle Pair		
	95.573	THE PARADE,MR628	TUMBARUMBA-S OF MR85,ALBURY ST	TOWN	--	--		Axle Pair		
	95.571	JINGELLIC RD,MR85	TUMBARUMBA-W OF COURABYRA RD	TOWN	1483	1476	1657	Axle Pair	1366	Vehicle
	95.194	ALBURY ST,MR85	TUMBARUMBA-W OF MR628,THE PARADE	TOWN	--	--		Axle Pair		
	94.056	HUME HWY,SH2	TUMBLONG-E OF MR280,ADELONG RD	52	--	--		Axle Pair		
	94.175	MR280	TUMBLONG-S OF SH2,HUME HWY	52	--	--		Axle Pair		
	95.482	MR278	TUMORRAMA-AT GUNDAGAI SHIRE BDY	52	--	--		Axle Pair		
	95.485	LACMALAC ROAD	TUMUT-8KM E OF MR278,YASS RD	52	--	--		Axle Pair		
	95.186	GUNDAGAI RD,MR279	TUMUT-AT GILMORE CK BR	TOWN	1846	2010	1692	Axle Pair	1302	Vehicle
	95.483	MR278	TUMUT-E OF BRUNGLE RD	52	171	221	150	Axle Pair	129	Vehicle
	95.538	LACMALAC RD	TUMUT-E OF WYNYARD ST	TOWN	--	--		Axle Pair		
	95.539	YASS RD,MR278	TUMUT-N OF DOWELL'S LANE	TOWN	1911	1923	1775	Axle Pair	1781	Vehicle
	95.534	FITZROY ST,SH4	TUMUT-N OF MR278,WEE JASPER RD	TOWN	3764	4295	4173	Axle Pair	4963	Axle Pair
	95.537	SNOWY MOUNTAINS HWY,SH4	TUMUT-S OF FOREST ST	TOWN	--	--		Axle Pair		
	95.185	YASS RD,MR278	TUMUT-S OF LACMALAC RD	TOWN	--	--		Axle Pair		
	95.536	FITZROY ST,SH4	TUMUT-S OF MR278,WEE JASPER RD	TOWN	--	--		Axle Pair		
	95.531	CAPPER ST	TUMUT-S OF SH4,ADELONG RD	TOWN	--	--		Axle Pair		
*	95.104	SNOWY MOUNTAINS HWY,SH4	TUMUT-S OF STONY CK BR	TOWN	1198	1211	1170	Axle Pair	1204	Axle Pair
	95.532	ADELONG RD,SH4	TUMUT-W OF MR279,GUNDAGAI RD	TOWN	6397	5633	6352	Axle Pair	6114	Axle Pair
	95.533	WYNYARD ST	TUMUT-W OF SH4,FITZROY ST	TOWN	--	--		Axle Pair		
	94.264	MR239	TYAGONG-AT WEDDIN SHIRE BDY	45	523	613	793	Axle Pair	559	Vehicle
	95.212	MR385	URANA-1KM N OF MR59,LOCKHART RD	51	467	466	510	Axle Pair	331	Vehicle
	95.339	ALBURY-URANA RD,MR125	URANA-24KM E OF MR59,LOCKHART RD	57	--	--		Axle Pair		
	95.211	MR59	URANA-AT RLY XING	51	1150	1372	1371	Axle Pair	973	Vehicle
	95.210	MR59	URANA-E OF MR125,WALBUNDRIE RD	51	--	--		Axle Pair		
	95.213	MR125	URANA-E OF MR131,DAYSDALE RD	51	--	--		Axle Pair		
	95.214	MR131	URANA-S OF MR125,WALBUNDRIE RD	51	527	496	583	Axle Pair	404	Vehicle
	95.282	KHANCOBAN RD,MR627	W OF KIANDRA RD	57	--	--		Axle Pair		
	97.242	KYALITE-MOULAMEIN RD	W OF MR296,MOULAMEIN RD	50	--	--		Axle Pair		

Volume Summary

Road	Mallee Hwy			**Survey Week**	
Location	west of Murray St (over bridge)	**Average Weekday**	1,056	1	
		7 Day Average	991		
Site No.	1	**Weekday Heavy Vehicle %**	20.20%	**Direction**	
Start Date	Fri 07/02/14	**7 Day Heavy Vehicle %**	18.14%	Both Directions Classes	
End Date	Sun 23/02/14	***GPS:***	***-35.031385° 143.333241°***		

Time	Survey Day								
	Fri	**Sat**	**Sun**	Mon	Tue	Wed	Thu	Averages	
	07/02/14	**08/02/14**	**09/02/14**	10/02/14	11/02/14	12/02/14	13/02/14	Weekday	7-day
0000-0100	8	8	23	5	11	8	9	8	10
0100-0200	8	9	3	5	6	12	11	8	8
0200-0300	8	6	4	4	5	5	6	6	5
0300-0400	9	6	6	4	2	6	7	6	6
0400-0500	7	9	3	1	6	8	3	5	5
0500-0600	25	16	7	26	20	31	27	26	22
0600-0700	45	18	20	35	34	42	38	39	33
0700-0800	56	22	23	62	59	57	77	62	51
0800-0900	72	41	38	75	98	69	81	79	68
0900-1000	49	55	56	45	64	75	67	60	59
1000-1100	66	56	67	33	56	58	58	54	56
1100-1200	75	50	46	51	73	47	68	63	59
1200-1300	50	53	53	62	50	63	68	59	57
1300-1400	68	65	50	62	69	74	66	68	65
1400-1500	56	51	58	71	78	72	88	73	68
1500-1600	71	56	62	75	78	75	97	79	73
1600-1700	75	43	63	81	88	65	74	77	70
1700-1800	77	67	43	90	73	59	69	74	68
1800-1900	62	71	44	60	62	77	47	62	60
1900-2000	60	54	38	59	60	48	58	57	54
2000-2100	37	38	39	35	34	32	17	31	33
2100-2200	41	20	22	31	53	20	23	34	30
2200-2300	30	30	19	28	18	24	7	21	22
2300-2400	6	18	8	6	7	13	4	7	9
Totals	**1,061**	**862**	**795**	**1,006**	**1,104**	**1,040**	**1,070**	1,056	991
% Heavy	16.40%	12.53%	13.46%	20.38%	21.38%	22.31%	20.56%	20.20%	18.14%

Peaks

0700-0900	128	63	61	137	157	126	158	141	119
1600-1800	152	110	106	171	161	124	143	150	138

Volume Summary

Road	Mallee Hwy			**Survey Week**
		Average Weekday	513	1
Location	west of Murray St (over bridge)	**7 Day Average**	483	
Site No.	1	**Weekday Heavy Vehicle %**	19.37%	**Direction**
Start Date	Fri 07/02/14	**7 Day Heavy Vehicle %**	17.43%	Westbound
End Date	Sun 23/02/14	***GPS:***	***-35.031385° 143.333241°***	

Time	Survey Day								
	Fri 07/02/14	Sat 08/02/14	Sun 09/02/14	Mon 10/02/14	Tue 11/02/14	Wed 12/02/14	Thu 13/02/14	Averages Weekday	Averages 7-day
0000-0100	4	4	19	1	3	1	3	2	5
0100-0200	2	3	2	3	0	1	5	2	2
0200-0300	4	3	2	2	0	2	0	2	2
0300-0400	2	3	3	1	2	4	4	3	3
0400-0500	3	3	0	0	2	5	2	2	2
0500-0600	13	10	5	17	14	16	16	15	13
0600-0700	29	10	10	25	22	31	24	26	22
0700-0800	32	14	11	33	34	33	45	35	29
0800-0900	42	24	22	38	41	34	44	40	35
0900-1000	24	36	36	27	34	44	37	33	34
1000-1100	32	34	38	21	21	25	23	24	28
1100-1200	37	21	27	20	34	25	28	29	27
1200-1300	18	17	25	34	30	29	33	29	27
1300-1400	29	26	23	29	41	33	29	32	30
1400-1500	24	18	26	30	37	28	45	33	30
1500-1600	38	29	29	44	48	41	58	46	41
1600-1700	29	14	30	29	40	25	31	31	28
1700-1800	33	28	23	30	23	26	31	29	28
1800-1900	19	20	20	14	21	28	19	20	20
1900-2000	24	13	20	29	24	21	25	25	22
2000-2100	14	16	20	23	19	21	10	17	18
2100-2200	28	12	14	13	36	15	13	21	19
2200-2300	22	21	11	13	10	20	3	14	14
2300-2400	5	13	3	1	3	4	4	3	5
Totals	**507**	**392**	**419**	**477**	**539**	**512**	**532**	513	483
% Heavy	16.96%	13.52%	11.69%	18.24%	20.59%	21.48%	19.55%	19.37%	17.43%

Peaks

0700-0900	74	38	33	71	75	67	89	75	64
1600-1800	62	42	53	59	63	51	62	59	56

Volume Summary

Road	Mallee Hwy			**Survey Week**
Location	west of Murray St (over bridge)	**Average Weekday**	543	1
		7 Day Average	509	
Site No.	1	**Weekday Heavy Vehicle %**	21.00%	**Direction**
Start Date	Fri 07/02/14	**7 Day Heavy Vehicle %**	18.87%	Eastbound
End Date	Sun 23/02/14	***GPS:***	***-35.031385° 143.333241°***	

Time	Survey Day								
	Fri	**Sat**	**Sun**	Mon	Tue	Wed	Thu	Averages	
	07/02/14	**08/02/14**	**09/02/14**	10/02/14	11/02/14	12/02/14	13/02/14	Weekday	7-day
0000-0100	4	4	4	4	8	7	6	6	5
0100-0200	6	6	1	2	6	11	6	6	5
0200-0300	4	3	2	2	5	3	6	4	4
0300-0400	7	3	3	3	0	2	3	3	3
0400-0500	4	6	3	1	4	3	1	3	3
0500-0600	12	6	2	9	6	15	11	11	9
0600-0700	16	8	10	10	12	11	14	13	12
0700-0800	24	8	12	29	25	24	32	27	22
0800-0900	30	17	16	37	57	35	37	39	33
0900-1000	25	19	20	18	30	31	30	27	25
1000-1100	34	22	29	12	35	33	35	30	29
1100-1200	38	29	19	31	39	22	40	34	31
1200-1300	32	36	28	28	20	34	35	30	30
1300-1400	39	39	27	33	28	41	37	36	35
1400-1500	32	33	32	41	41	44	43	40	38
1500-1600	33	27	33	31	30	34	39	33	32
1600-1700	46	29	33	52	48	40	43	46	42
1700-1800	44	39	20	60	50	33	38	45	41
1800-1900	43	51	24	46	41	49	28	41	40
1900-2000	36	41	18	30	36	27	33	32	32
2000-2100	23	22	19	12	15	11	7	14	16
2100-2200	13	8	8	18	17	5	10	13	11
2200-2300	8	9	8	15	8	4	4	8	8
2300-2400	1	5	5	5	4	9	0	4	4
Totals	**554**	**470**	**376**	**529**	**565**	**528**	**538**	543	509
% Heavy	15.88%	11.70%	15.43%	22.31%	22.12%	23.11%	21.56%	21.00%	18.87%

Peaks

0700-0900	54	25	28	66	82	59	69	66	55
1600-1800	90	68	53	112	98	73	81	91	82

Appendix C

Pavement Visual Inspection Methodology

3 Visual Inspection

3.1 Visual Inspection Introduction

A detailed visual site inspection of the pavement was undertaken between 23rd June 2014 and 28th June 2014 and up to 20km of pavement was reviewed on each day with areas of concern inspected on foot.

The weather during the site inspections was generally good and did not impact on the results of the inspection.

Given that pavement deformations within flexible pavements, are in most cases, a sign of failing pavement subgrade or road base courses the approach to the visual inspection was to log defects and these were typically identified by type, severity and general location. The pavements were generally observed to be defect free unless specifically noted. It should be noted that this visual inspection was more detailed than previous inspections and therefore supersedes any comments provided as part of earlier analysis.

The assessment of the pavement conditions is limited to those items that could be observed during the visual inspection and include the following.

Pavement Cracking

There are a number of types of cracks, including longitudinal, transverse, meandering, crescent, crocodile and block cracks. These have been logged and depending on the number, size and type of cracking have resulted in areas classified as low, medium or high severity

Table 3-1: Pavement Cracking Examples (Austroads Guide to Pavement Evaluation)

Pavement Cracking Examples		
Block Cracking	**Crocodile Cracking**	**Traverse Cracking**
		
Longitudinal	**Meandering**	**Crescent**
		

Pavement Deformation

Pavement deformation includes rutting, depression, corrugation and shoving. As with pavement cracking these are defined as low, medium or high severity. High severity surface deformations are an indication of potential structural issues including insufficient pavement thickness, inadequate pavement materials, weak subgrade and/or that the pavement may have reached the end of its design life.

Table 3-2: Pavement Deformation Examples (Austroads Guide to Pavement Evaluation)

Pavement Deformation Examples		
Rutting	**Depression**	**Corrugation**
		
	Shoving	
		

Surface Defects

These include observations in relation to patches and potholes, with the former generally logged in terms of the area of patch, and the second in terms of the number of potholes. Also included are surface issues that result in less skid resistance, including aggregate polishing, bleeding, binder loss and ravelling/stripping.

Table 3-3: Typical Pavement Defects

Surface Defect Examples		
Potholes	**Patches**	**Edge Break**
		

Aggregate Polishing	Binder Loss	Ravelling / Stripping
		
Bleeding	**Binder Oxidisation**	
		

Drainage Conditions

The road inspection has included a check of the general level of drainage along the road sections for information. This consisted of determining the health of roadside table drains, any noticeable crossfall and longitudinal grades of the road pavement, and the level of roadside vegetation that may have impeded the runoff of water from the pavement during rainfall events.

Criteria for Logging Defects

The VicRoads *Guide to Surface Inspection Rating* (Technical Bulletin 50, 2009) formed the basis for the evaluation of pavement defect types and defect severities on-site. These pavement condition ratings were developed by considering the extent of the defect over a given area and by the application of technical judgment over its visual severity.

The classification of defect types, and their categorization under groups such as Pavement Cracking, Pavement Deformation, and Pavement Defects, have been based on NAASRA's *Visual Assessment of Pavement Condition* (1987) and Austroads *Part 5: Pavement Evaluation and Treatment Design* (2011), in addition to the aforementioned Vicroads Technical Bulletin.

For each section of road an assessment of both the surface condition and the structural condition has been provided as appropriate.

Table 3-4 presents a summary of rating guidelines considered on-site, based on the above mentioned document references.

Table 3-4: Overview of Defect Assessment			
Defect Category and Typical Defects	**Assessment Guidelines**		
	Low Severity **(Rating 1 – 2)**	**Medium Severity** **(Rating 3)**	**High Severity** **(Rating 4-5)**
Pavement Cracking			
Longitudinal, Transverse, Meandering, Crescent, Block, Crocodile	• Cracking affects less than 10% of the area; and/or, • Mostly isolated cracks; and/or, • Crack widths less than 2mm	• Cracking affects between 10-20% of the area; and/or, • Cracks forming inter connections; and/or, • Crack widths approximately 2-3mm	• Cracking affects greater than 20% of the area; and/or, • Largely interconnected and consistent cracking; and/or, • Crack widths greater than 4mm
Pavement Deformation			
Rutting, Depression, Shoving, Corrugation	• Deformation affects less than 10% of the area; and/or, • Wheel-path rutting and general depression depths less than 10mm; and/or, • Shoving and Corrugations displace minor amounts of pavement material, less than 10mm in depth	• Deformation affects between 10-30% of the area; and/or, • Wheel-path rutting and general depression depths approximately 10-20mm; and/or, • Shoving and Corrugations displace moderate amounts of pavement material, between 10mm and 20mm in depth	• Deformation affects greater than 30% of the area; and/or, • Wheel-path rutting and general depression depths greater than 20mm; and/or, • Shoving and Corrugations displace moderate amounts of pavement material, greater than 20mm in depth
Pavement Defects (excluding edge breaks, potholes and patches)			
Aggregate Polishing, Binder Loss, Bleeding, Ravelling/Stripping	• Binder Loss: Binder generally coats greater than half, but less than two thirds, of the aggregate (spray seals) • Bleeding: Binder generally coats greater than two thirds of the aggregate (spray seals) • Bleeding: Minor loss in surface texture and/or affecting less than 10% of the area (asphalt) • Ravelling (asphalt) and Stripping (spray seals): Some loss of fine aggregate, single stone	• Binder Loss: Binder coats approximately a third of the aggregate (spray seals) • Bleeding: Binder generally coats most of the aggregate (spray seals) • Bleeding: Moderate loss in surface texture and/or affecting between 10% and 30% of the area (asphalt) • Ravelling (asphalt) and Stripping (spray seals): Noticeable loss and detachment of fine and course aggregate in pockets	• Binder Loss: Binder coats noticeably less than a third of the aggregate (spray seals) • Bleeding: Binder generally coats all of the aggregate and appears shiny in areas (spray seals) • Bleeding: High loss in surface texture and/or affecting more than 30% of the area (asphalt) • Ravelling (asphalt) and Stripping (spray seals): Widespread loss and detachment of fine and course aggregate, including delaminated areas

The assessment of the pavement condition is limited to those items that could be observed during the visual inspection. No detailed testing, sub-surface investigation, computation checks etc. were carried out at the time of the inspection. Areas where further strength testing may provide more useful data will be identified during the course of this assessment.

Except, as expressly stated otherwise, the inspections were carried out by Aurecon personnel and the report does not cover defects in inaccessible areas due to unfavourable road or traffic conditions that may have posed a safety hazard, thought these were rate. The main areas affected by this were the Murrumbidgeee River Bridge and the Edward River Bridge, with some spans being skipped altogether. Other minor effects in some unidentified areas of road containing tight corners or crests may have received a less detailed analysis.

The visual inspection logs and photographic records of the road pavements are included in Appendix B and Appendix D, respectively.

3.2 Visual Inspection Summary

Less than 10% of the total road length showed signs of distress, therefore the majority of the road pavements were deemed to be in a satisfactory condition, though on some roads more than 20% of the total road length was showing signs of pavement distress which deems this pavement condition relatively poor.

There was persistent moderate bleeding observed along the majority of the lengths of pavement to varying degrees. Severe pavement deformations that may be costly to repair and which usually indicate insufficient pavement thicknesses, inadequate pavement quality, weak subgrade and/or that the pavement may have reached the end of its design life, such as rutting and corrugation, were observed to be isolated.

For the purposes of the pavement analysis, Table 3-5, on the following page, outlines the reference sections of review.

3.3 Existing Pavement Condition

The general pavement condition of each section of road is summarised in the following sections which also include recommendations for areas where further pavement strength testing is required.

For the purpose of the site visit the 113km route was divided up into eight sections of road to be analysed, all of varying lengths, defined by distinguishable physical features. One of these sections is Tooleybuc Bridge, which is to be considered as a separate section due to its unique nature. A chainage of the length of route as a whole was taken as a reference for each road section and the corresponding defects. This chainage begins on Balranald Road 9.5km north of the Balranald Road/McCabe St intersection. These sections of road and their existing condition is summarised in Table 3-5 and Tables 3-6 to 3-12. Further detailed summaries of the existing pavement condition are attached in Appendix C.

Table 3-5: Existing Network Condition Summary

Road Name	Road Reference	Section Length	Section Width	Location	Preliminary Comments
Balranald-Ivanhoe Road	BR1	9.5km	7.2m	From potential Balranald-Ivanhoe Rd access location to McCabe Street	**General Comments:** Cruising speeds of approximately 100 km/h, lacks sealed shoulder, no edge marking. **Pavement conditions:** Intermittent transverse and longitudinal cracking, some rutting along both sides of the road primarily in the eastern lane, significant surface polishing in some areas.
McCabe Street	MS1	1.8km	7.2-11m	From Balranald Road to Sturt Highway (east of township)	**General Comments:** Cruising speeds of approximately 80km/h, lacks shoulder, no line marking. **Pavement conditions:** Significant texture loss in some areas accompanied by intermittent transverse and longitudinal cracking, some crocodile and meandering cracks.
Sturt Highway	SH4	2.8km	7.4m	From Balranald to Tooleybuc-Balranald Road	**General conditions:** Cruising speeds of approximately 110 km/h. Generally smooth driving conditions with a significant sealed shoulder, good road alignment and intersection alignment with appropriate vehicle movement separation. Bridges appear to all be in good condition with no significant issues recorded. **Pavement conditions:** Severe block and transverse cracking present on bridges. Persistent longitudinal and transverse cracking in some areas, localised crocodile cracking within asphalt surfaces, consistent bleeding under wheel paths the length of the road, some minor rutting and shoving.
Balranald-Tooleybuc Road	MH1A	53.6km	6.3-11.7m	From Sturt Highway to NSW/VIC Border	**General conditions:** Cruising speeds of over 100km/h. **Pavement conditions:** Persistent rutting and bleeding under wheel paths along the entire length of the road, accompanied by shoving in some locations. Localised longitudinal, transverse and crocodile cracking within asphalt surfaces in some areas. Significant patching of pavement in some areas. The timber bridge at Tooleybuc has a very worn pavement surface. Limited to no sealed shoulder in many areas.
Tooleybuc Bridge	-	0.3km	3.7m	On NSW/VIC border	**General conditions:** Murray River bridge at Tooleybuc is single lane and can carry only one heavy vehicle at a time. **Pavement conditions:** The bridge is asphalt lined timber, containing longitudinal cracks/separations at the timber joins.
Mallee Highway	MH1B	1.3km	6m	From NSW/VIC border to Murray Valley Highway	**General conditions:** Cruising speeds of around 100km/h. Limited visibility on NSW-bound approach to the Tooleybuc Bridge. Limited to no sealed shoulder in many areas. **Pavement conditions:** Persistent longitudinal and transverse cracking in some areas, localised crocodile cracking within asphalt surfaces, persistent bleeding under wheel paths.
Murray Valley Highway	MH2	1.9km	7.5m	From Tooleybuc Rd to Piangil turnoff	**General conditions:** Cruising speeds of approximately 110 km/h, generally smooth driving conditions with a significant sealed shoulder. **Pavement conditions:** Persistent longitudinal, transverse and meandering cracking in some areas, localised crocodile cracking within asphalt surfaces, minor rutting and persistent bleeding under wheel paths.
Mallee Highway	MH3	41.8km	6.6-7.1m	From Murray Valley Highway to Manangatang	**General conditions:** Cruising speeds of around 100 km/h. Limited to no sealed shoulder in many areas **Pavement conditions:** Persistent longitudinal, transverse and meandering cracking in some areas, localised crocodile cracking within asphalt surfaces, persistent rutting and bleeding under wheel paths the length of the road, accompanied by shoving in some areas. Numerous potholes in some areas.

Road Section 1: Balranald-Ivanhoe Road, BR1

This section of the road is approximately 9.5km in length. Areas of particular concern are summarised in Table 3.6.

Table 3-6: Road Section 1 – Existing Pavement Defects

Total Road Area of 68,400m^2

	Solitary Cracking (m^2)	Multiple Cracking Types (m^2)	Cracking Present with Rutting (m^2)	Crocodile Cracking (m^2)	Surface Deformation (m^2)	Surface Defects (m^2)
Area	1,047	4,200	530	523	1,556	11,505
Percentage of road area	2%	6%	1%	1%	2%	17%

Road Section 2: McCabe Street, MS1

McCabe Street is approximately 1.8km in length and is subject to an 80kph speed restriction from approximately 90 metres from the intersection with Balranald-Ivanhoe Road.

Aurecon understands that the road was originally constructed on top of a 3 metre wide levy bank. Plans and details of the construction of the road have not been able to be identified however Aurecon have undertaken a detailed investigation into the existing pavement analysis of this section of road, including geotechnical and feature surveys. This information is included within a separate report on McCabe Street.

However based on the visual inspection it is noted that the current pavement is generally in reasonable condition with limited cracking generally towards the southern end of the road and no visible surface deformations.

Table 3-7: Road Section 2 – Existing Pavement Defects

Total Road Area of 13,720m^2

	Solitary Cracking (m^2)	Multiple Cracking Types (m^2)	Cracking Present with Rutting (m^2)	Crocodile Cracking (m^2)	Surface Deformation (m^2)	Surface Defects (m^2)
Area	949	0	0	346	0	8,008
Percentage of road area	7%	0	0	3%	0	58%

Road Section 3: Sturt Highway, SH4

This section of the road is approximately 2.8km in length. Areas of particular concern are summarised in Table 3.8.

Table 3-8: Road Section 3 – Existing Pavement Defects

Total Road Area of 20,720m^2

	Solitary Cracking (m^2)	Multiple Cracking Types (m^2)	Cracking Present with Rutting (m^2)	Crocodile Cracking (m^2)	Surface Deformation (m^2)	Surface Defects (m^2)
Area	313	0	0	5.5	231	5,425
Percentage of road area	2%	0	0	<1%	1%	26%

Road Section 4: Balranald-Tooleybuc Road, MH1A

This section of the road is approximately 53.6km in length. Areas of particular concern are summarised in Table 3.9.

Table 3-9: Road Section 4 – Existing Pavement Defects

Total Road Area of 351,864m²

	Solitary Cracking (m^2)	Multiple Cracking Types (m^2)	Cracking Present with Rutting (m^2)	Crocodile Cracking (m^2)	Surface Deformation (m^2)	Surface Defects (m^2)
Area	3,442	529	297	1,287	8,187	31,356
Percentage of road area	1%	<1%	<1%	<1%	2%	9%

Road Section 5: Tooleybuc Bridge

The section of road classified as the Tooleybuc Bridge spans approximately 0.3km. It is noted that the Murray River Bridge at Tooleybuc, although accessible by General Mass Limit vehicles, comprises a narrow width across the centre of the span, accommodating a single traffic lane. This means that vehicles need to give way to oncoming traffic at the bridge and increases in traffic could result in material delays.

In addition, it is noted that the bridge comprises a partly wooden structure. The pavement condition across Tooleybuc Bridge is generally considered to be poor, however this is primarily considered to be as a result of the construction of the bridge with asphalt laid directly on top of the wooden structure.

It is understood that RMS have funds to upgrade the bridge however details of this upgrade are not known at this time. Aurecon understand that preliminary studies have been undertaken in relation to the bridge replace and a number of options considered. However it is understood that final designs have not been confirmed and a date of replacement is not known at this stage.

Therefore the impact of additional B Double movements across the existing bridge has been assessed within this result in terms general pavement wear and tear only.

Road Section 6: Mallee Highway #01, MH1B

This section of the road is approximately 1.3km in length. Areas of particular concern are summarised in Table 3.10.

Table 3-10: Road Section 6 – Existing Pavement Defects

Total Road Area – 7,860m²

	Solitary Cracking (m^2)	Multiple Cracking Types (m^2)	Cracking Present with Rutting (m^2)	Crocodile Cracking (m^2)	Surface Deformation (m^2)	Surface Defects (m^2)
Area	46	1,500	70	3,685	40	4,351
Percentage of road area	1%	19%	1%	47%	1%	56%

Road Section 7: Murray Valley Highway, MH2

This section of the road is approximately 1.9km in length. Areas of particular concern are summarised in Table 3.11.

Table 3-11: Road Section 7– Existing Pavement Defects Total Road Area – 14,550m^2						
	Solitary Cracking (m^2)	Multiple Cracking Types (m^2)	Cracking Present with Rutting (m^2)	Crocodile Cracking (m^2)	Surface Deformation (m^2)	Surface Defects (m^2)
Area	50	20	10	64	123	820
Percentage of road area	<1%	<1%	<1%	<1%	1%	6%

Road Section 8: Mallee Highway #02, MH3

This section of the road is approximately 41.8km in length. Areas of particular concern are summarised in Table 3.12.

Table 3-12: Road Section 8 – Existing Pavement Defects Total Road Area – 283,840m^2						
	Solitary Cracking (m^2)	Multiple Cracking Types (m^2)	Cracking Present with Rutting (m^2)	Crocodile Cracking (m^2)	Surface Deformation (m^2)	Surface Defects (m^2)
Area	7,914	32,413	585	30,361	4,686	77,771
Percentage of road area	3%	11%	<1%	11%	2%	27%

3.4 Existing Pavement Composition

Information regarding the existing pavement composition and subgrade strength was not available for this report. It is understood that the majority of the roads were formerly under the jurisdiction of local councils and the documentation containing detailed information regarding the existing pavement composition and subgrade strength are not readily available.

It is noted that information for McCabe Street is currently being gathered and can be reviewed following the completion of a separate report.

The Victorian Geological Map (1999, Geological Survey of Victoria) publication provides information on potential subgrade material in the general region of the haulage route and indicates that subgrade material for majority of the roads is likely to be predominantly sand. Given that in geological terms both the NSW and Victorian sections of the haulage route are similar, this sand subgrade material is anticipated to be relatively consistent along the entire route.

Typical CBR values for sand subgrade are between 8% and 15% and it is noted that geotechnical testing of McCabe Street in Balranald indicated a CBR value of subgrade of 8%, which accords with the geotechnical survey information viewed.

In lieu of specific details on the existing pavement composition typical design thicknesses have been used and the following assumptions have been adopted:

- Pavement thickness — Assumed to meet typical road authority[3] requirements for design traffic ranging from 0.3 million Equivalent Standard Axles (ESA) to 5 million ESA
- Subgrade CBR — Between 3% and 10%
- Subgrade material — Predominantly sand
- Pavement type — Unbound, flexible

The typical pavement design thicknesses are based on the unbound flexible pavement design chart in the VicRoads publication 'RC500.22 - Core of Practice for Selection and Design of Pavements and Surfacings' as shown in Table 3-13 for information purposes (on varying subgrade CBRs).

Borehole and geotechnical investigations are recommended in the detailed design stage. For more information on suggested future design phases, refer to Memorandum Balranald Mineral Sands – Task #07 – PaSE Testing Investigation (22 April 2014).

[3] *As stated previously VicRoads and RMS are based on the same Austroads principles but for consistency VicRoads documentation as the most comprehensive has been adopted*

Appendix D

NSW Route Road Safety Audit

Balranald Mine
Product Haulage Route

Balranald, NSW to Hopetoun, Victoria

Feasibility Road Safety Audit – NSW

Client:

Aurecon Australia Pty Ltd

Revision	Job No	Date Issued	Prepared by	Authorised by
Draft	120870	15/11/2012	Ian Holmes	Kate Kennedy
Final	120870	18/12/2012	Ian Holmes	Kate Kennedy

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EXECUTIVE SUMMARY

Trafficworks Pty Ltd has been engaged by Aurecon Australia Pty Ltd to undertake a feasibility road safety audit of a proposed mineral sands product haulage route between the mine site's potential access road, approximately 11 km north of Balranald, and a rail siding in Hopetoun, Victoria.

The audit made the following recommendations for consideration by the client and other interested parties.

INTOLERABLE RISK:

Balranald - Ivanhoe Road

- Nil

McCabe Street

- That a detailed review of the design and layout of the McCabe Street / BIR intersection be undertaken with an objective to:
  a) Provide appropriate right and left turn lanes at the intersection ;
  b) Provide appropriate intersection advance warning signs;
  c) Provide appropriate signs within the intersection;
  d) Remove the "see through effect" between McCabe Street and the BIR north approach to the intersection; and
  e) Provide street lighting at the intersection.

Sturt Highway

- Nil

Balranald – Tooleybuc Road

- Nil

HIGH RISK:

Balranald - Ivanhoe Road

- That two public lights be installed at the mine access road / BIR intersection, one on each of the north and south approaches to the intersection.
- That the delineation system along Balranald-Ivanhoe Road (BIR) be reviewed and enhanced to ensure it complies with AS1742.2.

  This will require improvements to the guidepost system and may require provision of curve warning signs, edge lines and raised reflective pavement markers (RRPMs).

- That the existing A size W2-4(L) Side Road Intersection warning sign north of the McCabe Street intersection be replaced with a B size W2-9(R) warning sign

McCabe Street

- That the delineation system along McCabe Street be reviewed and enhanced to ensure it complies with AS1742.2

This will require provision of edge and centre line marking, improved provision of CAMs, delineation of the lateral shift of the road northeast of the McCabe Street / Sturt Highway intersection, use of B size warning signs and may require provision of raised reflective pavement markers and modifications to the curve warning signs and the guidepost system

Sturt Highway

- That a Type CHR right turn treatment be provided at the Sturt Highway / Balranald-Tooleybuc Road (BTR) intersection.

Balranald – Tooleybuc Road

- That the delineation system along BTR be reviewed and enhanced to ensure it complies with AS1742.2.

  This will require improvements to the guidepost system, particularly through curvilinear and undulating sections, additional curve warning signs, width marker signs at the Wakool River bridges, use of B size signs as a minimum and may require provision of advisory speed signs, additional CAMs and raised reflective pavement markers.

MEDIUM RISK:

Balranald - Ivanhoe Road

- That the mine access road / BIR intersection be designed so that B-doubles turning to /from the mine access road can do so without encroaching onto opposing traffic lanes on each of the mine access road and the BIR.
- That the mine access road / BIR intersection be accompanied by advance and position intersection signs.

McCabe Street

- Nil

Sturt Highway

- That the operating conditions of the Sturt Highway / McCabe Street intersection be reviewed to ensure suitable sight distances are available for truck drivers entering the intersection from the southwest and northeast bound approaches to the intersection

  This will require removal of vegetation on the nature strip northwest of McCabe Street, relocation of direction signs on the south corner of the intersection and duplication of the Give Way sign on McCabe Street.

Balranald – Tooleybuc Road

- That all signing on the Victoria bound approach to the BTR / Murray Street (south) intersection and the NSW approach to the Murray River Bridge be reviewed and modified with the following objectives:

  a) Removal of unnecessary signs;

  b) Provision of advance intersection direction signs north of the intersection;

  c) Provision of a suitable Give Way a Ahead sign; and

  d) Ensure conspicuity of the Give Way sign and markings on the bridge approach.

LOW RISK:

Balranald - Ivanhoe Road

- Nil.

McCabe Street

- Nil

Sturt Highway

- That the eastbound Advance Intersection Direction sign for the Sturt Highway / BTR intersection be relocated to approximately 200m in advance of the intersection.

Balranald – Tooleybuc Road

- Nil

TABLE OF CONTENTS

INTRODUCTION

Trafficworks Pty Ltd has been engaged by Aurecon Australia Pty Ltd to undertake a feasibility road safety audit of a proposed mineral sands product haulage route between the mine site's potential access road, approximately 11 km north of Balranald, and a rail siding in Hopetoun, Victoria.

The audit was conducted by:

Ian Holmes [BE (Civil), Grad Dip Mun. Eng, Grad Dip Bus Admin]
Senior Road Safety Auditor

And reviewed by:

Kate Kennedy [BE (Civil)(Hons), BCom, MEngSc, CPEng]
Senior Road Safety Auditor

Haulage Route Details

The haulage route which is the subject of this audit is described below. The NSW section of the route is shown in Figure 1 and the route through Balranald is shown in Figure 2.

<u>NSW Section (64km)</u>

- Balranald – Ivanhoe Road: Between the potential mine access at the existing Balranald Gypsum pit entrance (approximately 11km north of the Sturt Highway in Balranald) and the McCabe Street intersection in Balranald (approximately 1.3km north of the Sturt Highway), haulage route section length of approximately 9.7km;
- McCabe Street, Balranald: Between the Balranald – Ivanhoe Road and the Sturt Highway, haulage route section length of approximately 1.7km;
- Sturt Highway, Balranald: Between McCabe Street and the Balranald – Tooleybuc Road, haulage route section length of approximately 3.2km; and
- Balranald – Tooleybuc Road: Between the Sturt Highway southeast of Balranald and the Murray River Bridge in Tooleybuc, haulage route section length of approximately 49km.

<u>Victoria Section (196km)</u>

- Mallee Highway: Between the Murray River Bridge in Tooleybuc and the Murray Valley Highway west of Tooleybuc, haulage route section length of approximately 1.5km;
- Murray Valley Highway: Between the Mallee Highway west of Tooleybuc and the Mallee Highway east of Piangil, haulage route section length of approximately 2km;
- Mallee Highway: Between the Murray Valley Highway east of Piangil and the Calder Highway at Ouyen, haulage route section length of approximately 97km;
- Calder Highway: Between the Mallee Highway at Ouyen and the Sunraysia Highway south of Ouyen, haulage route section length of approximately 11km;
- Sunraysia Highway: Between the Calder Highway south of Ouyen and the Henty Highway at Lascelles, haulage route section length of approximately 60km;

- Henty Highway: between the Sunraysia Highway at Lascelles and Austin Street, Hopetoun; , haulage route section length of approximately 24km; and
- Austin Street, Hopetoun: Between the Henty Highway and Garrard Street, Hopetoun; haulage route section length of approximately 0.5km.

Figure 1 – Haulage route in NSW (reproduced with permission from Melway Publishing Pty Ltd)

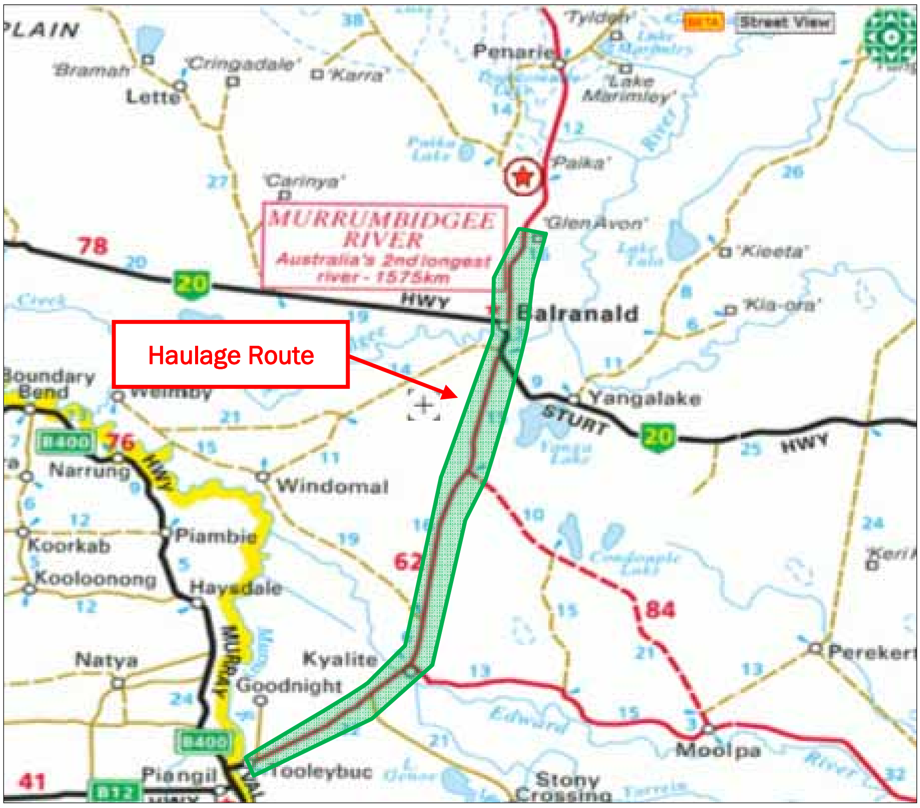
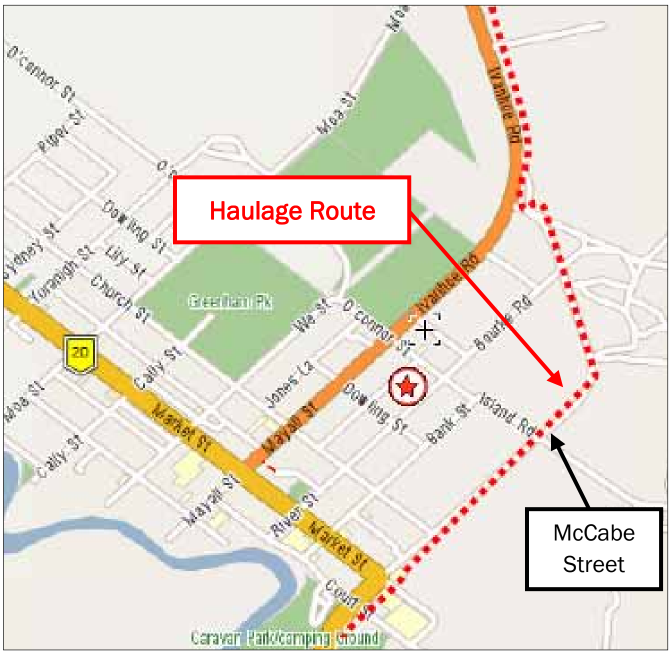


Figure 2 – Haulage route through Balranald (reproduced with permission from Melway Publishing Pty Ltd)



Key Aspects of the Haulage Route Roads

Road Lengths

Brief descriptions of each of the proposed haulage route road sections follow. The descriptions use information gathered during day and night time route inspections on 6 November 2012 and information in the updated draft *Pre-Feasibility Stage Route Review – NSW* report prepared by Aurecon, dated 23 October 2012 (referred to as PFSRR-NSW for this audit).

The PFSRR-NSW provides existing traffic volume data for various haulage route sections in terms of Passenger Car Equivalents (PCEs) where one B-double is 4 PCEs. The PFSRR-NSW estimates that post commencement of mine product haulage the traffic volumes will increase by 87 loaded B-doubles per day travelling from NSW to Victoria, allowing for return trips this is an additional 174 B-doubles or 696 additional PCEs per day.

As haulage will be undertaken uniformly throughout the day for 7 days a week the hourly increase in traffic will be 29 PCEs per hour (7.25 B-doubles per hour).

<u>Balranald – Ivanhoe Road</u>

Balranald – Ivanhoe Road (BIR) is classified as a Regional Main Road on which road trains are the largest vehicles permitted to travel without a permit.

The audited section of BIR is a 2 lane / 2 way road which consists of straights joined by moderately large radius curves. Sealed traffic lane widths vary between 3.4m and 3.7m, shoulders are unsealed and the centre line is marked. The vertical alignment is generally flat with a moderate crest in the order of 0.5 – 1.0km either side of the potential Iluka mine access location, i.e. in the vicinity of the existing Balranald Gypsum mine access. A 100km/h speed limit applies on this section of road.

The PFSRR-NSW estimates that 2015 pre-mine traffic volumes will be in the order of 780 vehicles per day (measured as Passenger Car Equivalents – PCEs), and post commencement of mine product haulage are estimated to increase to 1,476 PCEs/day.

A typical section of this road is shown in Photo 1.

Photo 1: Balranald – Ivanhoe Road, looking north from approximately 8km north of the McCabe Street intersection.

McCabe Street

McCabe Street is a local road which passes through an industrial estate and provides a “bypass” of central Balranald and residential areas. The largest vehicles allowed to use this road without a permit are road trains.

McCabe Street is a 2 lane / 2 way road which consists of straights and a curve at its mid length. This road has a 6.8m wide sealed pavement with unsealed verges. The pavement, at its south end, is constructed on fill which is approximately 2m high. The road’s vertical alignment is flat.

McCabe Street does not have any line marking; it relies on guideposts and curve warning / speed advisory signs and Chevron Alignment Markers (CAMs) on the mid-length curve for its delineation. An 80km/h speed limit applies on this road with the exception of the 250m approach to the Sturt Highway intersection which has a 50km/h speed limit.

The PFSRR-NSW does not provide an estimate of 2015 pre-mine traffic volumes on McCabe Street. Based on the site inspections it is estimated that existing traffic volumes on McCabe Street are in the order of 150 – 200 PCEs/day, and post commencement of mine product haulage the traffic volumes are estimated to increase to 850 – 900 PCEs/day.

A typical section of McCabe Street is shown in Photo 2.

Photo 2: McCabe Street, looking north from approximately 800m north of the Sturt Highway intersection.

Sturt Highway

Sturt Highway is classified as a State Highway. It is also a National Highway, on which road trains are the largest vehicles permitted to travel without a permit.

The audited section of the Sturt Highway is a 2 lane / 2 way road. Traffic lanes are sealed and are generally 3.5m wide with 1.5m wide sealed shoulders. The horizontal alignment is generally curvilinear with large radius curves; the vertical alignment is flat with the exception of the crest on the Murrumbidgee River Bridge in Balranald. Edge and centre lines are marked.

A 90km/h speed limit applies on this section of road; excepting on the 0.6 km section between the Murrumbidgee River Bridge south approach and the highway's intersection with McCabe Street along which a 50km/h speed limit applies.

The PFSRR-NSW estimates that 2015 pre-mine traffic volumes are in the order of 5,040 PCEs/day, and post commencement of mine product haulage are estimated to increase to 5,736 PCEs/day.

A typical section of this road is shown in Photo 3.

Photo 3: Sturt Highway, looking north from approximately 1.5m north of the Balranald – Tooleybuc Road intersection.

<u>Balranald – Tooleybuc Road</u>

Balranald – Tooleybuc Road (BTR) is classified as a State Main Road on which road trains are the largest vehicles permitted to travel without a permit.

BTR is a 2 lane / 2 way road which consists of sealed traffic lanes of between 3.1m and 3.5m widths, shoulders are generally unsealed and the edge and centre lines are marked. The horizontal alignment generally consists of straights joined by moderately large radius curves and the vertical alignment is generally moderately undulating with some long lengths of flat alignment. A 100km/h speed limit applies on this section of road with the exception of the Tooleybuc township where a 50km/h speed zone exists.

The PFSRR-NSW estimates that 2015 pre-mine traffic volumes are in the order of 1,770 PCEs/day, and post commencement of mine product haulage are estimated to increase to 2,466 PCEs/day.

A typical section of this road is shown in Photo 4.

Photo 4: Balranald – Tooleybuc Road, looking north from approximately 20km north of Tooleybuc.

Intersections

Key intersections along the haulage route are described below.

<u>Potential Mine Access / Balranald – Ivanhoe Road</u>

This intersection is in the vicinity of the existing Balranald Gypsum mine access intersection with BIR access. The existing intersection is a T-intersection where the existing access road approaches BIR as a two-lane two-way road which is sealed within 50m of the BIR. The speed limit on BIR, the through road, is 100km/h. Traffic flow and turning movements at the intersection are supported by widened seal pavement on the east side of BIR to assist heavy vehicle turns to and from the access road and assist southbound through vehicles to pass to the left of vehicles turning right into the side road. Limited shoulder sealing is provided on the west side of BIR to assist left turn movements to and from the access road.

Sight distances to the north and south from the side road, measured at 5m from the northbound traffic lane exceed 500m, thereby satisfying Austroads SISD requirements.

A typical view of the intersection is shown in Photo 5.

Photo 5: Existing Balranald Gypsum Mine Access / Balranald – Ivanhoe Road intersection, looking south through the intersection.

Balranald – Ivanhoe Road / McCabe Street

This is a T-intersection where McCabe Street intersects on the back of a curve on BIR, see Figure 2. The McCabe Street approach is along an intersection approach curve. The speed limit on BIR, the through road, is 100km/h.

Traffic flow and turning movements at the intersection are supported by widened seal pavement on the west side of BIR to assist northbound through vehicles to pass to the left of vehicles turning right into McCabe Street and a sealed shoulder on the east side of the north approach to allow vehicles turning left to McCabe Street to do so clear of the southbound traffic lane. The shoulder widening is not supported by line marking.

Sight distances to the north and south from McCabe Street, measured at 5m from the southbound traffic lane are approximately 320m to the south and 350m to the north, satisfying the Austroads Guide.

A typical view of the intersection is shown in Photo 6.

Photo 6: Balranald – Ivanhoe Road / McCabe Street intersection, looking west along the McCabe Street approach to the intersection.

Sturt Highway / McCabe Street

This is a cross road intersection where the Sturt Highway has 90^{o} turn between its northwest and southwest legs. The speed limit on the Sturt Highway, the through road, is 50km/h. All approaches to the intersection have splitter islands.

McCabe Street forms the northeast leg of the intersection, see Figure 2. The southeast leg of the intersection is an extension of Market Street which provides access to the Balranald Hospital and the Balranald Fire Station.

Give Way conditions apply to all intersection entry movements, other than the entry from the Sturt Highway's northwest approach and the left turn between the Sturt Highway's southwest and northwest approaches.

From the McCabe Street approach the sight distance to the northwest is constrained by trees on the northeast side nature strip. Measured at 3m from the Give Way line the sight distance to the northwest from truck driver eye height is approximately 60m which does not satisfy the Austroads Guide. To the southeast the sight distance from McCabe Street exceeds 150m which satisfy the AustRoads Guide.

From the Sturt Highway's southwest approach the sight distance to the northwest from the McCabe Street bound Give Way line is appropximately 150m. To the southeast the sight distance from a truck driver eye height is hindered by direction signs on the south corner of the intersection.

A typical view of the intersection is shown in Photo 7.

Photo 7: Sturt Highway (Market Street) / McCabe Street intersection, looking northeast through the intersection from the Sturt Highway southwest approach to McCabe Street.

<u>Sturt Highway / Balranald – Tooleybuc Road</u>

This is a T intersection where the BTR intersects with the Sturt Highway at an angle of approximately 60°. The speed limit on the Sturt Highway, the through road, is 90km/h.

Traffic flow and turning movements at the intersection are supported by widened seal pavement on the northeast side of the highway to assist southeast bound through vehicles to pass to the left of vehicles turning right into BTR and a sealed left turn lane on the southwest side of the intersection. The widened pavement and left turn lane are line marked.

Sight distances from BTR exceed 250m to the northwest and 500m to the southeast.

A typical view of the intersection is shown in Photo 8.

Photo 8: Sturt Highway / Balranald – Tooleybuc Road intersection, looking northwest from the intersection.

Balranald – Tooleybuc Road / Murray Street (north intersection)

This is a T-intersection where the BTR has a 90º turn through the intersection with Murray Street, the main street of Tooleybuc. Murray Street is the priority road at this intersection, it has a speed limit of 50km/h which is reduced to 40km/h during school start and end times. All approaches to the intersection have splitter islands.

Sight distances to the north and south along Murray Street from the BTR east approach are estimated to exceed 150m and satisfy the Austroads Guide.

Turning movements by trucks are supported by No Standing restrictions along the west side of Murray Street and widened pavement on the north side of the BTR eastbound traffic lane as it exits the intersection.

A typical view of the intersection is shown in Photo 9.

Photo 9: Balranald – Tooleybuc Road / Murray Street north intersection, looking north to the intersection. The Balranald – Tooleybuc Road has a 90° turn at this intersection to the right as photographed.

Balranald – Tooleybuc Road / Murray Street (south intersection)

This is an altered T-intersection where the BTR has a 90° turn through its intersection with Murray Street. The 90° turn is the BTR's approach to the Tooleybuc Bridge over the Murray River.

At this location the 90° turn of the BTR is the through movement, the Murray Street south approach is Give Way controlled. Vehicles approaching the river bridge from this intersection are controlled by a Give Way sign at the bridge which gives priority to NSW bound bridge traffic.

Each approach to the intersection has a 50km/h speed limit; however operating speeds through the intersection are estimated to be in the order of 40km/h only. The intersection has splitter islands to control BTR through traffic and traffic on the Murray Street south approach.

The west bound exit from the intersection, i.e. the approach to the Murray River Bridge has a complex array of signs with many different messages.

A typical view of the intersection is shown in Photo 10.

Photo 10: Balranald – Tooleybuc Road / Murray Street south intersection, looking south to the intersection. The Balranald – Tooleybuc Road has a 90º turn at this intersection to the right as photographed, i.e. to the Murray River Bridge.

Casualty Crashes

Casualty crash data for the proposed haulage route has been provided by Roads and Maritime Services – NSW for the period from 2007 to early 2012 (the most recent data available).

The data provided identifies the following crash history for sections of the haulage route as follows:

Balranald – Ivanhoe Road

There are no recorded casualty crashes recorded along the subject section of Balranald – Ivanhoe Road in the period reviewed.

McCabe Street

There are no recorded casualty crashes recorded along McCabe Street in the period reviewed.

Sturt Highway

During the period reviewed there have been two casualty crashes on the subject section of the Sturt Highway.

One crash involved a B-Double failing to stop at the T-intersection end of the Balranald - Tooleybuc Road, a RUM 75 crash – off end of road at T intersection. This crash occurred at night in dry conditions. The crash resulted in one person being injured.

The second crash occurred 10m west of the Balranald - Tooleybuc Road intersection and involved a car running off the carriageway to the left into a tree / shrub, RUM 71 – left off carriageway into object. This crash occurred at night in dry conditions. The crash resulted in one person being injured.

<u>Balranald – Tooleybuc Road</u>

During the period reviewed there have been four casualty crashes recorded on the Balranald - Tooleybuc Road.

Each of the four crashes were single vehicle run-off road crashes on straight sections of road, RUM 71, 2 x 72 and 73. Three crashes involved passenger vehicles (two cars and one 4 wheel drive) and one involved a semi-trailer. Three of the crashes occurred during the day and one at dawn, all occurred in dry conditions. One crash, the RUM 73 crash, resulted in two people being injured, and three crashes resulted in one person being injured in each crash.

The crash locations are distributed along the Balranald – Tooleybuc Road.

<u>Summary</u>

The casualty crash records do not identify any demonstrable priority road safety deficiencies along the proposed haulage route in NSW.

Site Inspections

The following site inspections were conducted on Tuesday 6th November 2012.

- Day time inspection, during the afternoon. Weather conditions were overcast and generally dry, occasional short showers occurred at various locations along the route; and
- Night time inspection. Weather conditions were clear.

Supporting Information Used in the Audit

The documents and references as noted below were used when conducting the audit.

- *Pre-Feasibility Stage Route Review – NSW* updated draft report prepared by Aurecon, dated 23 October 2012 (referred to as PFSRR-NSW for this audit).

References

- Austroads *Guide to Road Design, Part 3 – Geometric Design,* for sight distance criteria (referred to in this RSA as GTRD3).
- Austroads *Guide to Road Design, Part 4A – Unsignalised and Signalised Intersections,* for sight distance criteria and intersection types (referred to in this RSA as GTRD4A).
- Australian Standard *AS 1742.2 – 2009 Manual of uniform traffic control devices Part2: Traffic control devices for general use,* for sign types and use (referred to in this RSA as AS1742.2).

Road Safety Audit Process

This Road Safety Audit has been conducted in accordance with the procedures set out in the AustRoads Guide to Road Safety Part 6: Road Safety Audit (2009). It has reviewed the site and the details contained within the supporting documentation to identify issues which affect road user safety. The auditor cannot guarantee that every issue that affects road user safety has been identified. Although the adoption of the audit recommendations will improve the level of safety of the site it will not, however, eliminate all the road user safety risks.

The findings included within the audit have been given a risk rating based on the likelihood of a crash occurring as a result of the deficiency together with the potential consequence of that crash.

The risk ratings adopted are as follows:

- Intolerable
- High
- Medium
- Low

Trafficworks also denotes a risk rating of "Note only" for drafting errors, omissions, issues recognised to be outside the scope of works, and items to be noted within the scope of works that do not constitute a road safety risk. Tables 1 – 3 demonstrate the risk rating assessment process.

Table 1: Likelihood of a crash (source: Austroads Guide to Road Safety Part 6: Road Safety Audit)

Frequency	Description
Frequent	Once or more per week
Probable	Once or more per year (but less than once a week)
Occasional	Once every five to ten years
Improbable	Less often than once every ten years

Table 2: Likely severity of a crash (source: Austroads Guide to Road Safety Part 6: Road Safety Audit)

Severity	Description	Examples
Catastrophic	Likely multiple deaths	High speed, multi-vehicle crash on a freeway Car runs into crowded bus stop Bus and petrol tanker collide Collapse of a bridge or tunnel
Serious	Likely deaths or serious injury	High or medium speed vehicle/vehicle collision High or medium speed collision with a fixed roadside object Pedestrian or cyclists struck by a car
Minor	Likely minor injury	Some low speed vehicle collisions Cyclist falls from bicycle at low speed Left-turn rear-end crash in a slip lane
Limited	Likely trivial injury or property damage only	Some low speed vehicle collisions Pedestrian walks into object (no head injury) Car reverses into post

Table 3: Resulting level of risk (source: Austroads Guide to Road Safety Part 6: Road Safety Audit)

	Frequent	Probable	Occasional	Improbable
Catastrophic	Intolerable	Intolerable	Intolerable	High
Serious	Intolerable	Intolerable	High	Medium
Minor	Intolerable	High	Medium	Low
Limited	High	Medium	Low	Low

The Safe System Approach has been formally adopted by VicRoads and Austroads. Research has found the chances of surviving a crash decrease markedly above certain speeds, depending on the type of crash:

- Pedestrian struck by vehicle 20 to 30 km/h
- Motorcyclist struck by vehicle (or falling off) 20 to 30 km/h
- Side-impact vehicle striking a pole or tree 30 to 40 km/h
- Side-impact vehicle to vehicle crash 50 km/h
- Head-on vehicle to vehicle (equal mass) crash 70 km/h

Road Safety Audits are a formal process and the audit findings and recommendations should be responded to by the client in writing. If recommendations are not accepted by the client then reasons should be included within the written response. A client is under no obligation to accept all the audit findings and recommendations and should consider these in conjunction with all other project considerations. It is not the role of the auditor to approve the client's response to an audit.

FINDINGS AND RECOMMENDATIONS

The Findings and Recommendations are provided in the following table and are identified by approximate southbound haulage route chainage (HRC Ch xx) along each haulage route section. Where appropriate, photos are provided in Attachment A to support findings and recommendations.

	Audit Findings	Audit Recommendations	Risk Rating	Client Response Accept: Yes / No	Client Response Reasons / Comments
1	**Balranald - Ivanhoe Road (HRC Ch 0.0 – 9.7km)**				
1.1	HRC Ch 0.0: Mine access road intersection. 50% of haulage transport movements at this intersection will occur at night time. It is appropriate that street lighting be provided at this location to: a) Assist drivers to identify where the access road intersection is; and b) Illuminate vehicles that are entering BIR from the access road for improved conspicuity of these vehicles for drivers approaching the intersection along BIR.	That two public lights be installed at the mine access road / BIR intersection, one on each of the north and south approaches to the intersection.	Likelihood: Occasional Severity: Serious **Risk Rating: HIGH**		
1.2	HRC Ch 0.0: Mine access road intersection. It is appropriate that vehicles travelling to and from the mine access road at the intersection do so without encroaching onto opposing direction traffic lanes.	That the mine access road / BIR intersection be designed so that B-doubles turning to /from the mine access road can do so without encroaching onto opposing traffic lanes on each of the mine access road and the BIR.	Likelihood: Improbable Severity: Serious **Risk Rating: MEDIUM**		

1.3	HRC Ch 0.0: Mine access road intersection. It is appropriate that the location of the mine access road / BIR intersection be prominent for all road users. In addition to the street lighting recommended in Item 1.1, it is appropriate that the intersection be accompanied by advance and position intersection signs.	That the mine access road / BIR intersection be accompanied by advance and position intersection signs.	Likelihood: Improbable Severity: Serious **Risk Rating: MEDIUM**		
1.4	HRC Ch 2.0 – 3.5: Reverse curves The reverse curves at this location are poorly defined by the existing BIR's guidepost system; the deficiencies of the system are more obvious at night time. It is appropriate that the delineation of the curves, and all other sections of the BIR, be of a suitable standard for both day and night time usage.	That the delineation system along BIR be reviewed and enhanced to ensure it complies with AS1742.2. This will require improvements to the guidepost system and may require provision of curve warning signs, edge lines and raised reflective pavement markers (RRPMs).	Likelihood: Occasional Severity: Serious **Risk Rating: HIGH**		
1.5	HRC Ch 9.5: McCabe Street intersection approach The north approach to the McCabe Street intersection has an aged A size W2-4(L) Side Road Intersection warning sign. This sign has almost zero reflectivity at night time and provides a very confusing message to approaching drivers during the day and no message at night. See **Photo A1 in Attachment A**. The need for appropriate signing at this location is increased when night time haulage traffic begins to use McCabe Street.	That the existing A size W2-4(L) Side Road Intersection warning sign north of the McCabe Street intersection be replaced with a B size W2-9(R) warning sign.	Likelihood: Occasional Severity: Serious **Risk Rating: HIGH**		

2	McCabe Street (HRC Ch 9.7 – 11.4km)				
2.1	HRC Ch 9.7: McCabe Street / BIR Intersection The McCabe Street / BIR intersection is a T – intersection on the back of a medium radius curve. The McCabe Street approach to the intersection is also a curve which meets the BIR at 90º. The turning movements to / from McCabe Street are supported by a 2m widening of BIR opposite McCabe Street to assist north bound through vehicles to pass to the left of right turning vehicles and a sealed shoulder on the northeast side of the north approach to the intersection to assist vehicles turning left into McCabe Street. The intersection has a number of deficiencies including: a) Lack of definition of turning lanes on BIR; b) An A size W2-3 T-intersection straight ahead approach warning sign, see **Photo A2**, where a B size W2-14(L) sign should be used; c) Poor conspicuity of signs within the intersection, see **Photo A2**, the poor conspicuity is of increased concern at night time; d) A "see through effect" along the "straight link" between McCabe Street and the BIR north approach to the intersection, see **Photos A1 and A3;** and e) A lack of public lighting.	That a detailed review of the design and layout of the McCabe Street / BIR intersection be undertaken with an objective to: a) Provide appropriate right and left turn lanes at the intersection; b) Provide appropriate intersection advance warning signs; c) Provide appropriate signs within the intersection; d) Remove the "see through effect" between McCabe Street and the BIR north approach to the intersection; and e) Provide street lighting at the intersection.	Likelihood: Probable Severity: Serious **Risk Rating: INTOLERABLE**		

2.2	HRC Ch 9.7 – 11.4 (BIR to Sturt Highway) Delineation of McCabe Street relies on a guidepost system plus curve warning / 60km/h advisory speed signs and Chevron Alignment Markers (CAMs) on the curve at 500 – 900m southeast of BIR. It is noted that the above curve is a compound curve through which the safe operating speed reduces for southeast bound travel. Delineation deficiencies include: a) Lack of centre and edge line markings, see **Photo 2**; b) Use of A size warning signs and CAMs; c) Inconsistent spacing of CAMs through the curve; and d) Lack of definition of the lateral shift that occurs in the road alignment outside K & SL Nelson Nominees Pty Ltd grain store, approximately 150m northeast of the McCabe Street / Sturt Highway intersection, see **Photo A4**. It is appropriate that the delineation system be enhanced to be suitable for night time use of McCabe Street.	That the delineation system along McCabe Street be reviewed and enhanced to ensure it complies with AS1742.2. This will require provision of edge and centre line markings, improved provision of CAMs, delineation of the lateral shift of the road northeast of the McCabe Street / Sturt Highway intersection, use of B size warning signs and may require provision of raised reflective pavement markers and modifications to the curve warning signs and the guidepost system.	Likelihood: Occasional Severity: Serious **Risk Rating: HIGH**		

3	Sturt Highway (HRC Ch 11.4 – 14.6km)				
3.1	HRC Ch 11.4 Sturt Highway / McCabe Street Intersection. Sight lines between vehicles entering the intersection and traffic on adjacent approaches is limited at some locations that will be used by haulage route traffic. Intersection deficiencies include: a) Sight lines between southwest bound McCabe Street traffic and southeast bound Sturt Highway traffic which is constrained by vegetation on the nature strip northwest of the intersection, see **Photo A5**; and b) Sight lines for truck drivers between northeast bound traffic from the Sturt Highway and northwest bound Market Street traffic which are hindered by intersection direction signs, see **Photo A6**; and c) Lack of prominence of the Give Way sign on the McCabe Street approach to the intersection.	That the operating conditions of the Sturt Highway / McCabe Street intersection be reviewed to ensure suitable sight distances are available for truck drivers entering the intersection from the southwest and northeast bound approaches to the intersection. This will require removal of vegetation on the nature strip northwest of McCabe Street, relocation of direction signs on the south corner of the intersection and duplication of the Give Way sign on McCabe Street.	Likelihood: Occasional Severity: Minor **Risk Rating: MEDIUM**		

3.2	HRC Ch 14.5 Balranald – Tooleybuc Road (BTR) intersection approach. The eastbound Advance Intersection Direction sign for the Sturt Highway / BTR intersection is only 135m in advance of the intersection and is located on the inside of a curve. This location is considered to be too close to the intersection to give sufficient advance warning of the intersection.	That the eastbound Advance Intersection Direction sign for the Sturt Highway / BTR intersection be relocated to approximately 200m in advance of the intersection.	Likelihood: Improbable Severity: Minor **Risk Rating: LOW**		
3.3	HRC Ch 14.6 Sturt Highway / BTR intersection. The right turn movement from the Sturt Highway to BTR is supported by a wide sealed shoulder, with linemarking, to allow through traffic to pass to the left of right turning vehicles. This wide sealed shoulder becomes a left turn lane for entry to the Caltex Roadhouse located approximately 300m east of the intersection. The wide sealed shoulder provides a Type AUR right turn treatment. Safety at the intersection, particularly at night, will be improved with the provision of a protected right turn lane, Type CHR right turn treatment, for movements to BTR.	That a Type CHR right turn treatment be provided at the Sturt Highway / BTR intersection.	Likelihood: Occasional Severity: Serious **Risk Rating: HIGH**		

4	**Balranald – Tooleybuc Road (HRC Ch 14.6 – 63.6km)**				
4.1	HRC 14.6 – 62.7 Sturt Highway – Tooleybuc town entrance. The existing delineation system consists of centre and edge line marking, a guidepost system, curve delineation systems (particularly through the curves in the vicinity of HRC Ch 23.0 to 25.5) and RRPMs on relatively short sections. Deficiencies in the delineation system include: a) Inconsistent use of RRPMs; b) Poor conspicuity of centre and edge lines on light coloured pavement seals; c) Inadequate numbers of guideposts through undulating and curvilinear sections; d) A number of curve warning signs missing; e) Lack of advisory speed signs with curve warning signs; f) Use of A size signs; and g) Lack of D4-3 Width Marker signs on the approaches to the Wakool River bridges at HRC Ch 47.0.	That the delineation system along BTR be reviewed and enhanced to ensure it complies with AS1742.2. This will require improvements to the guidepost system, particularly through curvilinear and undulating sections, additional curve warning signs, width marker signs at the Wakool River bridges, use of B size signs as a minimum and may require provision of advisory speed signs, additional CAMs and raised reflective pavement markers.	Likelihood: Occasional Severity: Serious **Risk Rating: HIGH**		

4.2	HRC Ch 63.6 - BTR / Murray Street intersection (south), approach to the Murray River Bridge. At this intersection the BTR has a low speed 90° curve between Murray Street and the Murray River Bridge. For Victoria bound travel this intersection and approach to the bridge has the following deficiencies: a) Lack of an advance intersection direction sign advising of the 90° turn at the intersection for Victoria bound travel; b) A W3-2, Give Way Ahead, sign with a straight ahead arrow rather than a "to the right" arrow; see **Photo 10**; c) A complex array of information, regulatory and warning signs on the approach to the bridge, see **Photo A7**; and d) Poor conspicuity of the Give Way sign which controls entry onto the bridge.	That all signing on the Victoria bound approach to the BTR / Murray Street (south) intersection and the NSW approach to the Murray River Bridge be reviewed and modified with the following objectives: a) Removal of unnecessary signs; b) Provision of advance intersection direction signs north of the intersection; c) Provision of a suitable Give Way Ahead sign; and d) Ensure conspicuity of the Give Way sign and markings on the bridge approach.	Likelihood: Occasional Severity: Minor **Risk Rating: MEDIUM**		

Client response completed by:

Name:..

Signed:..Date:..

CONCLUSION

This Road Safety Audit has been conducted in accordance with the procedures set out in the Austroads Guide to Road Safety Part 6: Road Safety Audits (2009). The site has been inspected and the supporting documentation has been examined. The findings and recommendations are provided for consideration by the client and any other interested parties.

Auditors:

.... (18th December 2012)

Ian Holmes [BE (Civil), Grad Dip Mun. Eng, Grad Dip Bus Admin]
Senior Road Safety Auditor

.... (18th December 2012)

Kate Kennedy [BE (Civil)(Hons), BCom, MEngSc, CPEng]
Senior Road Safety Auditor

ATTACHMENT A – PHOTOGRAPHS

Photo A1 – Looking southeast along BIR towards McCabe Street in the background. The McCabe Street intersection is located to the right of the photo on the back of the right hand curve of BIR. This photo shows the aged, and inappropriate, side road intersection warning sign and the see through effect that exists on a straight alignment to McCabe Street. At night the reflectors on the guideposts along McCabe Street amplify the potential see through effect

Photo A2 – Looking west along McCabe Street to the BIR intersection. Shows the inappropriate use of a W2-3, T-intersection straight approach, warning sign and the limited conspicuity of the signs within the intersection.

Photo A3 – Looking northwest along McCabe Street to the BIR's north approach to the McCabe Street / BIR intersection. This shows the "see through effect" that exists between the two sections of road, see the yellow arrow. The risk of this "see through effect" contributing to run-off road crashes is increased at night.

Photo A4 – Looking southwest along McCabe Street towards the McCabe Street / Sturt Highway intersection. Shows the wide pavement which exists outside K & SL Nelson Nominees Pty Ltd grain store operations, approximately 150m northeast of the Sturt Highway intersection. The traffic paths along McCabe Street have a lateral shift through this section of McCabe Street. At night the lateral shift is not clear and the correct through path not apparent for drivers.

Photo A5 – Looking northwest along the Sturt Highway from McCabe Street's northeast entry to the Sturt Highway / McCabe Street intersection. Shows vegetation on the nature strip controlling sight lines to approaching traffic, available sight distance from truck driver eye height is approximately 60m, short of the desirable Safe Intersection Sight Distance of 104m for trucks travelling at 50km/h.

Photo A6 – Looking southeast along from the Sturt Highway's southwest approach to the Sturt Highway / McCabe Street intersection. Shows the Intersection Direction Signs which hinder sight lines to the southeast for truck drivers, the truck drivers sight line "through the sign" when at the Give Way sign is demonstrated by the red arrows.

Photo A7 – Looking west along Balranald – Tooleybuc Road to the Murray River Bridge. Shows the array of information, regulatory and warning signs on the NSW approach to the bridge. The Give Way sign, which controls entry onto the bridge, lacks conspicuity for approaching drivers, and no accompanying hold line is visible.

Appendix E

RMS Accident Data for Balranald and Wakool LGAs

Summary Crash Report

# Crash Type		
Car Crash	54	70.1%
Light Truck Crash	7	9.1%
Rigid Truck Crash	1	1.3%
Articulated Truck Crash	19	24.7%
'Heavy Truck Crash	(19)	(24.7%)
Bus Crash	0	0.0%
"Heavy Vehicle Crash	(19)	(24.7%)
Emergency Vehicle Crash	0	0.0%
Motorcycle Crash	7	9.1%
Pedal Cycle Crash	0	0.0%
Pedestrian Crash	1	1.3%

' Rigid or Artic. Truck " Heavy Truck or Heavy Bus
These categories are NOT mutually exclusive

Location Type		
*Intersection	14	18.2%
Non intersection	63	81.8%

* Up to 10 metres from an intersection
~ 07:30-09:30 or 14:30-17:00 on school days

Collision Type		
Single Vehicle	62	80.5%
Multi Vehicle	15	19.5%

Road Classification		
Freeway/Motorway	0	0.0%
State Highway	57	74.0%
Other Classified Road	11	14.3%
Unclassified Road	9	11.7%

Contributing Factors		
Speeding	16	20.8%
Fatigue	20	26.0%
Alcohol	4	5.2%

Weather		
Fine	67	87.0%
Rain	8	10.4%
Overcast	1	1.3%
Fog or mist	0	0.0%
Other	0	0.0%

Road Surface Condition		
Wet	10	13.0%
Dry	67	87.0%
Snow or ice	0	0.0%

Natural Lighting		
Dawn	3	3.9%
Daylight	41	53.2%
Dusk	3	3.9%
Darkness	30	39.0%

Crash Movement		
Intersection, adjacent approaches	3	3.9%
Head-on (not overtaking)	2	2.6%
Opposing vehicles; turning	1	1.3%
U-turn	0	0.0%
Rear-end	3	3.9%
Lane change	0	0.0%
Parallel lanes; turning	0	0.0%
Vehicle leaving driveway	0	0.0%
Overtaking; same direction	1	1.3%
Hit parked vehicle	0	0.0%
Hit railway train	0	0.0%
Hit pedestrian	0	0.0%
Permanent obstruction on road	0	0.0%
Hit animal	13	16.9%
Off road, on straight	12	15.6%
Off road on straight, hit object	16	20.8%
Out of control on straight	3	3.9%
Off road, on curve	4	5.2%
Off road on curve, hit object	9	11.7%
Out of control on curve	0	0.0%
Other crash type	10	13.0%

Speed Limit					
			~ 40km/h or less	1	10.0%
40 km/h or less	1	1.3%	80 km/h zone	7	9.1%
50 km/h zone	9	11.7%	90 km/h zone	1	1.3%
60 km/h zone	1	1.3%	100 km/h zone	15	19.5%
70 km/h zone	0	0.0%	110 km/h zone	43	55.8%

CRASHES	77	
Fatal crash	5	6.5%
Injury crash	41	53.2%
Non-casualty crash	31	40.3%

CASUALTIES	69	
Killed	5	7.2%
Injured	64	92.8%
^ Unrestrained	1	1.4%

^ Belt fitted but not worn, No restraint fitted to position OR No helmet worn

Time Group			% of Day
00:01 - 02:59	6	7.8%	12.5%
03:00 - 04:59	8	10.4%	8.3%
05:00 - 05:59	1	1.3%	4.2%
06:00 - 06:59	3	3.9%	4.2%
07:00 - 07:59	5	6.5%	4.2%
08:00 - 08:59	6	7.8%	4.2%
09:00 - 09:59	6	7.8%	4.2%
10:00 - 10:59	3	3.9%	4.2%
11:00 - 11:59	0	0.0%	4.2%
12:00 - 12:59	4	5.2%	4.2%
13:00 - 13:59	4	5.2%	4.2%
14:00 - 14:59	3	3.9%	4.2%
15:00 - 15:59	3	3.9%	4.2%
16:00 - 16:59	4	5.2%	4.2%
17:00 - 17:59	2	2.6%	4.2%
18:00 - 18:59	4	5.2%	4.2%
19:00 - 19:59	3	3.9%	4.2%
20:00 - 21:59	8	10.4%	8.3%
22:00 - 24:00	4	5.2%	8.3%

Street Lighting Off/Nil			% of Dark
26	of	30 in Dark	86.7%

Crashes		Casualties
15	2013	9
20	2012	21
11	2011	11
20	2010	19
11	2009	9

~ School Travel Time		
Involvement	10	13.0%

McLean Periods			% Week
A	14	18.2%	17.9%
B	9	11.7%	7.1%
C	14	18.2%	17.9%
D	3	3.9%	3.5%
E	3	3.9%	3.6%
F	9	11.7%	10.7%
G	2	2.6%	7.1%
H	6	7.8%	7.1%
I	6	7.8%	12.5%
J	11	14.3%	10.7%

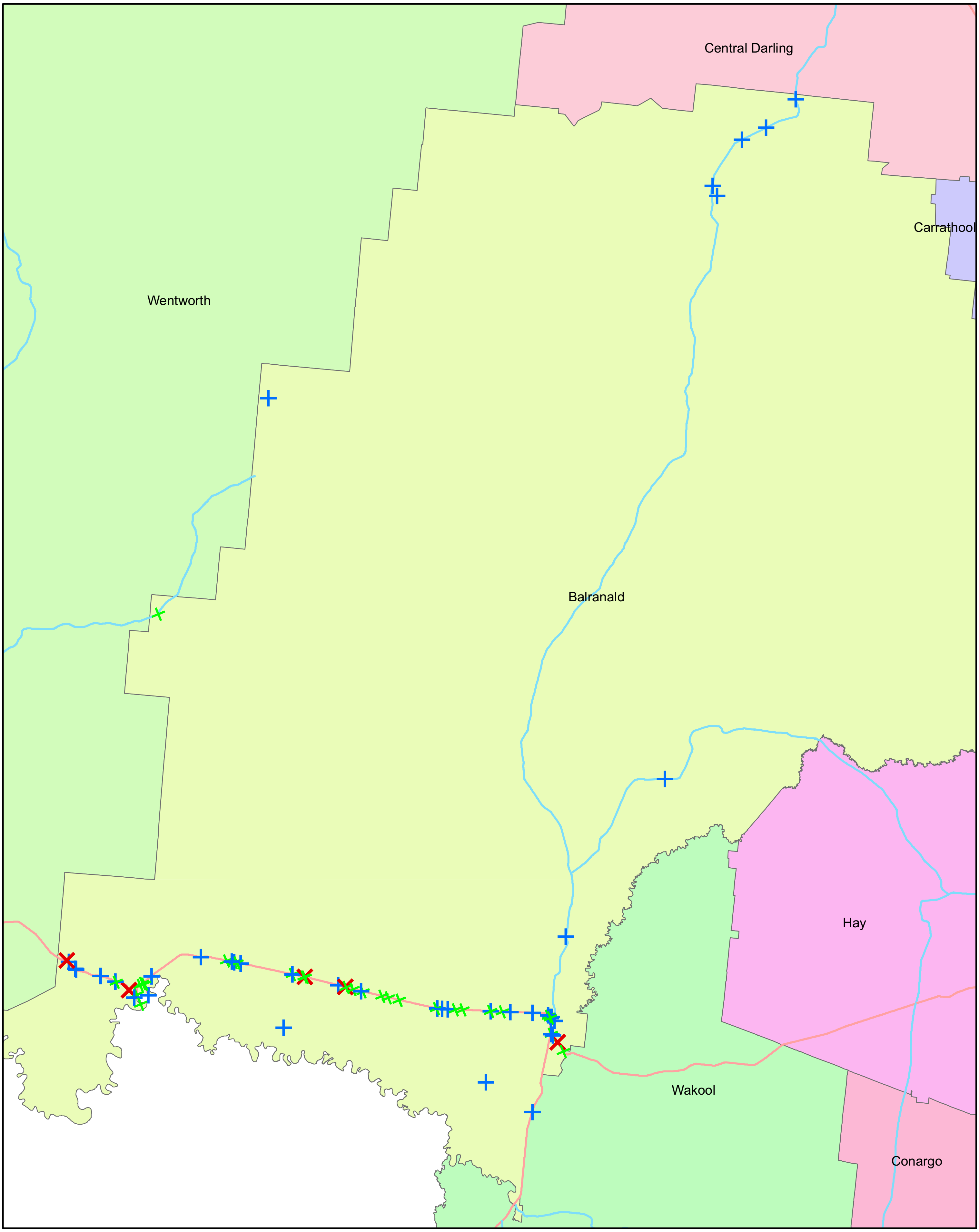
Day of the Week								
Monday	7	9.1%	Thursday	14	18.2%	Sunday	11	14.3%
Tuesday	6	7.8%	Friday	11	14.3%	WEEKDAY	52	67.5%
Wednesday	14	18.2%	Saturday	14	18.2%	WEEKEND	25	32.5%

# Holiday Periods								
New Year	1	1.3%	Queen's BD	3	3.9%	Easter SH	3	3.9%
Aust. Day	0	0.0%	Labour Day	0	0.0%	June/July SH	5	6.5%
Easter	1	1.3%	Christmas	1	1.3%	Sept./Oct. SH	3	3.9%
Anzac Day	1	1.3%	January SH	6	7.8%	December SH	1	1.3%

Daily dataset Balranald LGA all crashes for 2009, 2010, 2011, 2012, 2013 reporting years.

Percentages are percentages of all crashes. Unknown values for each category are not shown on this report.

Balranald LGA Crashes 2009-2013



Summary Crash Report

# Crash Type		
Car Crash	49	66.2%
Light Truck Crash	15	20.3%
Rigid Truck Crash	0	0.0%
Articulated Truck Crash	6	8.1%
'Heavy Truck Crash	(6)	(8.1%)
Bus Crash	0	0.0%
"Heavy Vehicle Crash	(6)	(8.1%)
Emergency Vehicle Crash	0	0.0%
Motorcycle Crash	9	12.2%
Pedal Cycle Crash	0	0.0%
Pedestrian Crash	3	4.1%

' Rigid or Artic. Truck " Heavy Truck or Heavy Bus
These categories are NOT mutually exclusive

Location Type		
*Intersection	7	9.5%
Non intersection	67	90.5%

* Up to 10 metres from an intersection
~ 07:30-09:30 or 14:30-17:00 on school days

Collision Type		
Single Vehicle	59	79.7%
Multi Vehicle	15	20.3%

Road Classification		
Freeway/Motorway	0	0.0%
State Highway	12	16.2%
Other Classified Road	23	31.1%
Unclassified Road	39	52.7%

Contributing Factors		
Speeding	18	24.3%
Fatigue	13	17.6%
Alcohol	9	12.2%

Weather		
Fine	60	81.1%
Rain	3	4.1%
Overcast	9	12.2%
Fog or mist	1	1.4%
Other	0	0.0%

Road Surface Condition		
Wet	12	16.4%
Dry	61	83.6%
Snow or ice	0	0.0%

Natural Lighting		
Dawn	3	4.1%
Daylight	50	67.6%
Dusk	2	2.7%
Darkness	19	25.7%

Crash Movement		
Intersection, adjacent approaches	3	4.1%
Head-on (not overtaking)	2	2.7%
Opposing vehicles; turning	0	0.0%
U-turn	0	0.0%
Rear-end	4	5.4%
Lane change	0	0.0%
Parallel lanes; turning	0	0.0%
Vehicle leaving driveway	1	1.4%
Overtaking; same direction	1	1.4%
Hit parked vehicle	0	0.0%
Hit railway train	0	0.0%
Hit pedestrian	2	2.7%
Permanent obstruction on road	0	0.0%
Hit animal	3	4.1%
Off road, on straight	12	16.2%
Off road on straight, hit object	19	25.7%
Out of control on straight	6	8.1%
Off road, on curve	3	4.1%
Off road on curve, hit object	8	10.8%
Out of control on curve	3	4.1%
Other crash type	7	9.5%

Speed Limit					
~ 40km/h or less	2	16.7%			
40 km/h or less	4	5.4%	80 km/h zone	0	0.0%
50 km/h zone	12	16.2%	90 km/h zone	0	0.0%
60 km/h zone	1	1.4%	100 km/h zone	45	60.8%
70 km/h zone	1	1.4%	110 km/h zone	11	14.9%

CRASHES	74	
Fatal crash	10	13.5%
Injury crash	43	58.1%
Non-casualty crash	21	28.4%

CASUALTIES	73	
Killed	10	13.7%
Injured	63	86.3%
^ Unrestrained	9	12.3%

^ Belt fitted but not worn, No restraint fitted to position OR No helmet worn

Time Group			% of Day
00:01 - 02:59	3	4.1%	12.5%
03:00 - 04:59	2	2.7%	8.3%
05:00 - 05:59	2	2.7%	4.2%
06:00 - 06:59	7	9.5%	4.2%
07:00 - 07:59	3	4.1%	4.2%
08:00 - 08:59	4	5.4%	4.2%
09:00 - 09:59	7	9.5%	4.2%
10:00 - 10:59	3	4.1%	4.2%
11:00 - 11:59	4	5.4%	4.2%
12:00 - 12:59	3	4.1%	4.2%
13:00 - 13:59	4	5.4%	4.2%
14:00 - 14:59	9	12.2%	4.2%
15:00 - 15:59	4	5.4%	4.2%
16:00 - 16:59	5	6.8%	4.2%
17:00 - 17:59	2	2.7%	4.2%
18:00 - 18:59	2	2.7%	4.2%
19:00 - 19:59	4	5.4%	4.2%
20:00 - 21:59	2	2.7%	8.3%
22:00 - 24:00	4	5.4%	8.3%

Street Lighting Off/Nil			% of Dark
18	of	19 in Dark	94.7%

Crashes		Casualties
14	2013	14
11	2012	12
16	2011	18
19	2010	16
14	2009	13

~ School Travel Time		
Involvement	12	16.2%

McLean Periods			% Week
A	11	14.9%	17.9%
B	7	9.5%	7.1%
C	23	31.1%	17.9%
D	6	8.1%	3.5%
E	1	1.4%	3.6%
F	9	12.2%	10.7%
G	2	2.7%	7.1%
H	7	9.5%	7.1%
I	2	2.7%	12.5%
J	6	8.1%	10.7%

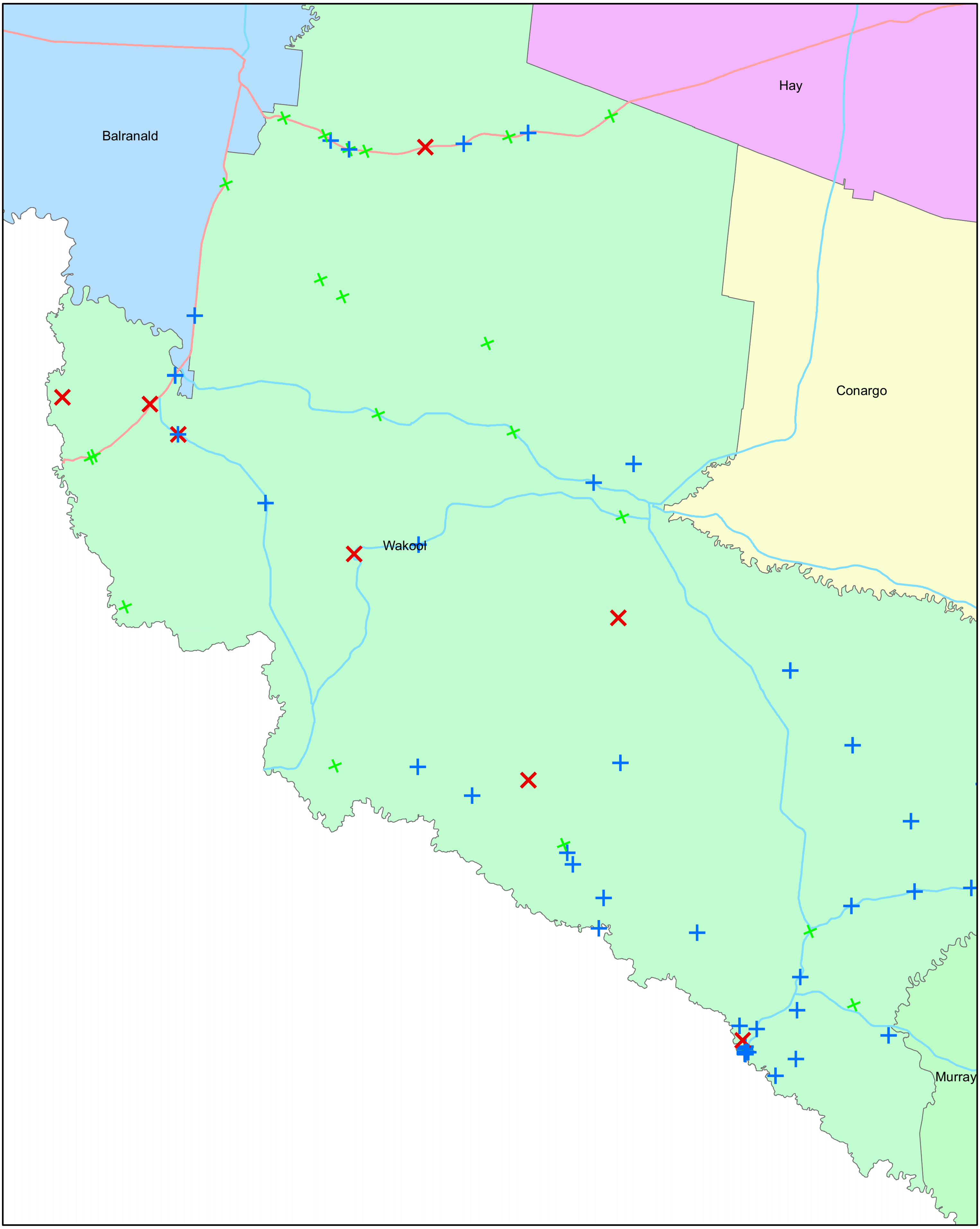
Day of the Week								
Monday	14	18.9%	Thursday	7	9.5%	Sunday	11	14.9%
Tuesday	8	10.8%	Friday	10	13.5%	WEEKDAY	48	64.9%
Wednesday	9	12.2%	Saturday	15	20.3%	WEEKEND	26	35.1%

# Holiday Periods								
New Year	0	0.0%	Queen's BD	1	1.4%	Easter SH	9	12.2%
Aust. Day	1	1.4%	Labour Day	2	2.7%	June/July SH	3	4.1%
Easter	5	6.8%	Christmas	0	0.0%	Sept./Oct. SH	5	6.8%
Anzac Day	1	1.4%	January SH	4	5.4%	December SH	0	0.0%

Daily dataset Wakool LGA all crashes for 2009, 2010, 2011, 2012, 2013 reporting years.

Percentages are percentages of all crashes. Unknown values for each category are not shown on this report.

Wakool LGA Crashes 2009-2013



Appendix F

SIDRA Intersection Analysis Results

MOVEMENT SUMMARY

Site: Sturt Highway Mayall Street AM 2014

Four Way Town Centre Intersection
Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mayall Street											
1	L	19	14.0	0.021	7.2	LOS A	0.1	0.5	0.18	0.57	42.6
2	T	8	14.0	0.016	7.5	LOS A	0.1	0.5	0.39	0.53	42.5
3	R	2	14.0	0.016	9.0	LOS A	0.1	0.5	0.39	0.66	41.7
Approach		29	14.0	0.021	7.4	LOS A	0.1	0.5	0.25	0.57	42.5
East: Sturt Highway											
4	L	1	14.0	0.041	6.8	LOS A	0.0	0.0	0.00	0.93	43.3
5	T	72	14.0	0.041	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
6	R	6	14.0	0.006	7.4	LOS A	0.0	0.2	0.22	0.57	42.4
Approach		79	14.0	0.041	0.7	NA	0.0	0.2	0.02	0.06	49.2
North: Mayall Street											
7	L	15	14.0	0.017	7.3	LOS A	0.1	0.4	0.20	0.57	42.6
8	T	2	14.0	0.021	8.0	LOS A	0.1	0.6	0.40	0.51	41.8
9	R	11	14.0	0.021	9.7	LOS A	0.1	0.6	0.40	0.66	40.9
Approach		27	14.0	0.021	8.3	LOS A	0.1	0.6	0.30	0.60	41.9
West: Sturt Highway											
10	L	21	14.0	0.072	7.1	LOS A	0.4	3.1	0.22	0.61	42.9
11	T	78	14.0	0.072	0.4	LOS A	0.4	3.1	0.22	0.00	47.0
12	R	19	14.0	0.072	7.3	LOS A	0.4	3.1	0.22	0.74	42.9
Approach		118	14.0	0.072	2.7	NA	0.4	3.1	0.22	0.23	45.5
All Vehicles		254	14.0	0.072	3.2	NA	0.4	3.1	0.17	0.25	45.8

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Sturt Highway Mayall Street AM 2018 - Base

Four Way Town Centre Intersection
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mayall Street											
1	L	21	14.0	0.024	7.2	LOS A	0.1	0.6	0.19	0.57	42.6
2	T	15	14.0	0.026	7.9	LOS A	0.1	0.8	0.42	0.57	42.2
3	R	2	14.0	0.026	9.4	LOS A	0.1	0.8	0.42	0.69	41.4
Approach		38	14.0	0.026	7.6	LOS A	0.1	0.8	0.29	0.58	42.4
East: Sturt Highway											
4	L	1	14.0	0.045	6.8	LOS A	0.0	0.0	0.00	0.93	43.3
5	T	79	14.0	0.045	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
6	R	13	14.0	0.012	7.5	LOS A	0.0	0.3	0.23	0.58	42.3
Approach		93	14.0	0.045	1.1	NA	0.0	0.3	0.03	0.09	48.7
North: Mayall Street											
7	L	21	14.0	0.024	7.4	LOS A	0.1	0.6	0.22	0.57	42.5
8	T	7	14.0	0.042	8.4	LOS A	0.2	1.3	0.43	0.55	41.5
9	R	17	14.0	0.042	10.1	LOS A	0.2	1.3	0.43	0.70	40.6
Approach		45	14.0	0.042	8.6	LOS A	0.2	1.3	0.33	0.62	41.6
West: Sturt Highway											
10	L	28	14.0	0.082	7.2	LOS A	0.5	3.6	0.24	0.59	42.9
11	T	85	14.0	0.082	0.4	LOS A	0.5	3.6	0.24	0.00	46.7
12	R	21	14.0	0.082	7.4	LOS A	0.5	3.6	0.24	0.73	42.8
Approach		135	14.0	0.082	2.9	NA	0.5	3.6	0.24	0.24	45.2
All Vehicles		311	14.0	0.082	3.8	NA	0.5	3.6	0.20	0.29	45.3

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Sturt Highway Mayall Street
AM 2018 - With Project

Four Way Town Centre Intersection
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mayall Street											
1	L	21	14.0	0.024	7.2	LOS A	0.1	0.6	0.19	0.57	42.6
2	T	21	14.0	0.037	8.1	LOS A	0.1	1.1	0.43	0.58	42.1
3	R	2	14.0	0.037	9.6	LOS A	0.1	1.1	0.43	0.71	41.2
Approach		44	14.0	0.037	7.8	LOS A	0.1	1.1	0.32	0.58	42.3
East: Sturt Highway											
4	L	1	14.0	0.045	6.8	LOS A	0.0	0.0	0.00	0.93	43.3
5	T	79	14.0	0.045	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
6	R	19	14.0	0.018	7.5	LOS A	0.1	0.5	0.24	0.58	42.3
Approach		99	14.0	0.045	1.5	NA	0.1	0.5	0.05	0.12	48.2
North: Mayall Street											
7	L	27	14.0	0.031	7.4	LOS A	0.1	0.8	0.22	0.58	42.5
8	T	14	14.0	0.065	8.7	LOS A	0.3	2.0	0.45	0.58	41.3
9	R	23	14.0	0.065	10.4	LOS A	0.3	2.0	0.45	0.73	40.5
Approach		64	14.0	0.065	8.7	LOS A	0.3	2.0	0.35	0.63	41.5
West: Sturt Highway											
10	L	35	14.0	0.086	7.2	LOS A	0.5	3.8	0.25	0.58	42.9
11	T	85	14.0	0.086	0.4	LOS A	0.5	3.8	0.25	0.00	46.7
12	R	21	14.0	0.086	7.4	LOS A	0.5	3.8	0.25	0.72	42.8
Approach		141	14.0	0.086	3.1	NA	0.5	3.8	0.25	0.25	45.1
All Vehicles		348	14.0	0.086	4.3	NA	0.5	3.8	0.22	0.33	44.8

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Sturt Highway Mayall Street AM 2020 - Base

Four Way Town Centre Intersection
Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mayall Street											
1	L	22	14.0	0.025	7.3	LOS A	0.1	0.6	0.20	0.57	42.6
2	T	15	14.0	0.027	8.1	LOS A	0.1	0.8	0.43	0.57	42.1
3	R	2	14.0	0.027	9.5	LOS A	0.1	0.8	0.43	0.70	41.3
Approach		39	14.0	0.027	7.7	LOS A	0.1	0.8	0.30	0.58	42.3
East: Sturt Highway											
4	L	1	14.0	0.047	6.8	LOS A	0.0	0.0	0.00	0.93	43.3
5	T	82	14.0	0.047	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
6	R	13	14.0	0.012	7.5	LOS A	0.0	0.3	0.24	0.58	42.3
Approach		96	14.0	0.047	1.1	NA	0.0	0.3	0.03	0.09	48.7
North: Mayall Street											
7	L	22	14.0	0.025	7.4	LOS A	0.1	0.6	0.23	0.58	42.5
8	T	7	14.0	0.045	8.6	LOS A	0.2	1.4	0.44	0.56	41.3
9	R	18	14.0	0.045	10.3	LOS A	0.2	1.4	0.44	0.71	40.5
Approach		47	14.0	0.045	8.7	LOS A	0.2	1.4	0.34	0.62	41.5
West: Sturt Highway											
10	L	29	14.0	0.086	7.2	LOS A	0.5	3.8	0.25	0.59	42.9
11	T	89	14.0	0.086	0.4	LOS A	0.5	3.8	0.25	0.00	46.7
12	R	22	14.0	0.086	7.4	LOS A	0.5	3.8	0.25	0.73	42.8
Approach		141	14.0	0.086	2.9	NA	0.5	3.8	0.25	0.24	45.2
All Vehicles		323	14.0	0.086	3.8	NA	0.5	3.8	0.20	0.29	45.2

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Sturt Highway Mayall Street
AM 2020 - With Project

Four Way Town Centre Intersection
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mayall Street											
1	L	22	14.0	0.025	7.3	LOS A	0.1	0.6	0.20	0.57	42.6
2	T	22	14.0	0.039	8.3	LOS A	0.2	1.2	0.44	0.59	41.9
3	R	2	14.0	0.039	9.8	LOS A	0.2	1.2	0.44	0.72	41.1
Approach		46	14.0	0.039	7.9	LOS A	0.2	1.2	0.33	0.59	42.2
East: Sturt Highway											
4	L	1	14.0	0.047	6.8	LOS A	0.0	0.0	0.00	0.93	43.3
5	T	82	14.0	0.047	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
6	R	20	14.0	0.019	7.6	LOS A	0.1	0.5	0.25	0.58	42.3
Approach		103	14.0	0.047	1.5	NA	0.1	0.5	0.05	0.12	48.2
North: Mayall Street											
7	L	29	14.0	0.033	7.4	LOS A	0.1	0.8	0.23	0.58	42.5
8	T	15	14.0	0.073	8.9	LOS A	0.3	2.2	0.46	0.59	41.1
9	R	25	14.0	0.073	10.6	LOS A	0.3	2.2	0.46	0.74	40.3
Approach		69	14.0	0.073	8.9	LOS A	0.3	2.2	0.36	0.64	41.4
West: Sturt Highway											
10	L	37	14.0	0.090	7.2	LOS A	0.5	4.0	0.25	0.57	42.8
11	T	89	14.0	0.090	0.4	LOS A	0.5	4.0	0.25	0.00	46.6
12	R	22	14.0	0.090	7.4	LOS A	0.5	4.0	0.25	0.72	42.8
Approach		148	14.0	0.090	3.1	NA	0.5	4.0	0.25	0.25	45.0
All Vehicles		367	14.0	0.090	4.4	NA	0.5	4.0	0.23	0.33	44.7

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

Processed: Tuesday, 11 November 2014 4:32:58 PM
SIDRA INTERSECTION 5.1.13.2093

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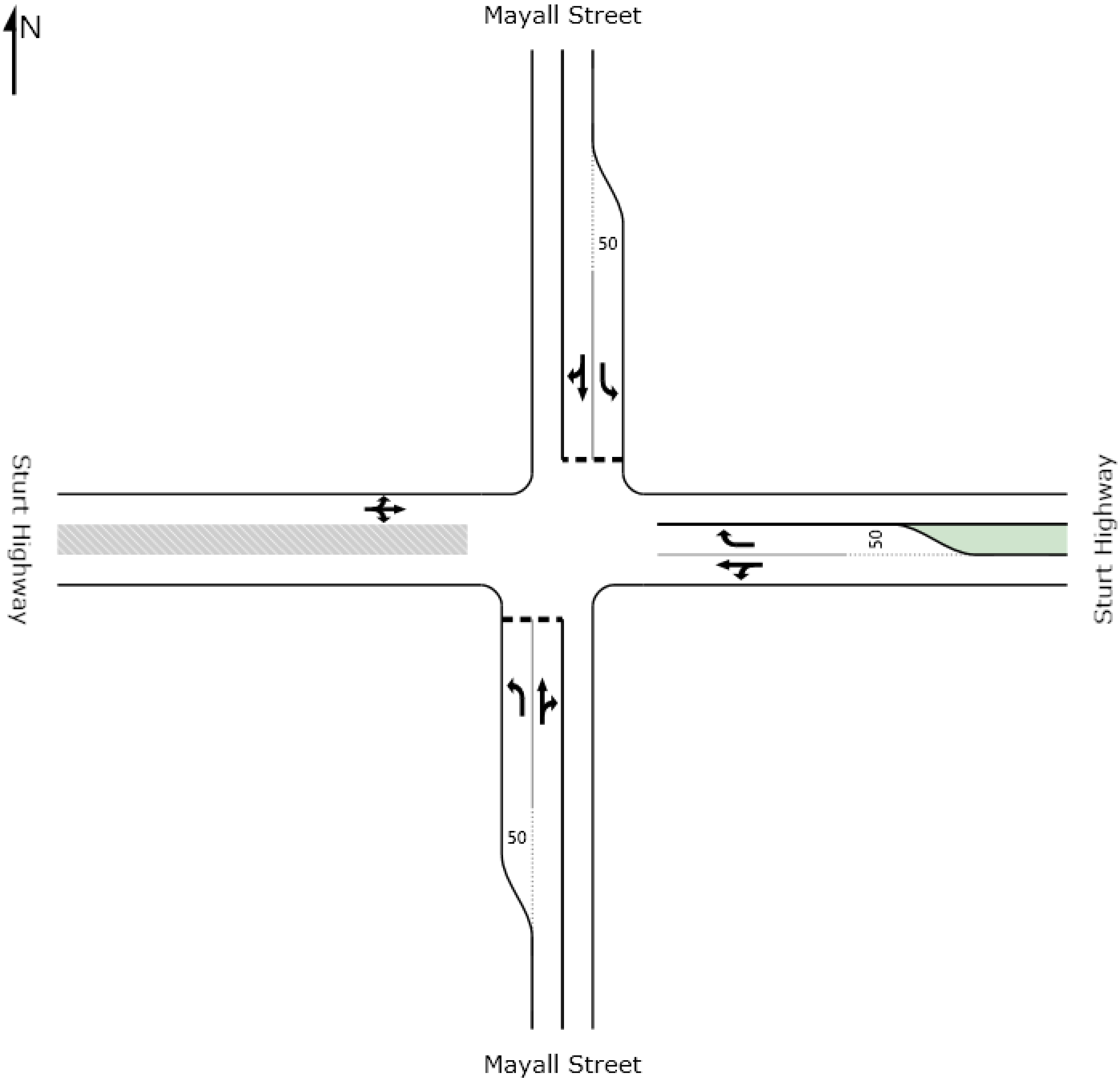
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Mayall Street
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Sturt Highway
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Mayall Street

MOVEMENT SUMMARY

Site: Sturt Highway Mayall Street
PM 2014

Four Way Town Centre Intersection
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mayall Street											
1	L	34	12.0	0.037	7.3	LOS A	0.1	0.9	0.22	0.58	42.5
2	T	19	12.0	0.046	8.4	LOS A	0.2	1.4	0.45	0.59	41.7
3	R	8	12.0	0.046	9.9	LOS A	0.2	1.4	0.45	0.71	40.9
Approach		61	12.0	0.046	8.0	LOS A	0.2	1.4	0.33	0.60	42.0
East: Sturt Highway											
4	L	11	12.0	0.061	6.7	LOS A	0.0	0.0	0.00	0.89	43.3
5	T	99	12.0	0.061	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
6	R	6	12.0	0.006	7.4	LOS A	0.0	0.2	0.24	0.57	42.3
Approach		116	12.0	0.061	1.0	NA	0.0	0.2	0.01	0.11	48.8
North: Mayall Street											
7	L	17	12.0	0.019	7.3	LOS A	0.1	0.5	0.23	0.57	42.5
8	T	8	12.0	0.038	8.8	LOS A	0.1	1.1	0.46	0.58	41.2
9	R	13	12.0	0.038	10.5	LOS A	0.1	1.1	0.46	0.73	40.3
Approach		38	12.0	0.038	8.7	LOS A	0.1	1.1	0.36	0.62	41.4
West: Sturt Highway											
10	L	23	12.0	0.095	7.3	LOS A	0.5	4.2	0.27	0.56	42.8
11	T	97	12.0	0.095	0.5	LOS A	0.5	4.2	0.27	0.00	46.3
12	R	34	12.0	0.095	7.5	LOS A	0.5	4.2	0.27	0.73	42.8
Approach		154	12.0	0.095	3.1	NA	0.5	4.2	0.27	0.24	44.9
All Vehicles		368	12.0	0.095	3.8	NA	0.5	4.2	0.21	0.30	45.2

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Sturt Highway Mayall Street
PM 2018 Base

Four Way Town Centre Intersection
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mayall Street											
1	L	37	12.0	0.041	7.4	LOS A	0.1	1.0	0.24	0.58	42.5
2	T	26	12.0	0.063	9.0	LOS A	0.2	1.9	0.49	0.63	41.2
3	R	9	12.0	0.063	10.5	LOS A	0.2	1.9	0.49	0.75	40.5
Approach		73	12.0	0.063	8.4	LOS A	0.2	1.9	0.36	0.62	41.7
East: Sturt Highway											
4	L	12	12.0	0.067	6.7	LOS A	0.0	0.0	0.00	0.89	43.3
5	T	108	12.0	0.067	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
6	R	13	12.0	0.012	7.5	LOS A	0.0	0.3	0.26	0.58	42.3
Approach		133	12.0	0.067	1.3	NA	0.0	0.3	0.02	0.13	48.5
North: Mayall Street											
7	L	24	12.0	0.027	7.4	LOS A	0.1	0.7	0.24	0.58	42.4
8	T	15	12.0	0.065	9.5	LOS A	0.2	1.9	0.50	0.62	40.6
9	R	19	12.0	0.065	11.2	LOS A	0.2	1.9	0.50	0.77	39.8
Approach		58	12.0	0.065	9.2	LOS A	0.2	1.9	0.39	0.65	41.1
West: Sturt Highway											
10	L	31	12.0	0.108	7.3	LOS A	0.6	4.8	0.30	0.54	42.8
11	T	106	12.0	0.108	0.6	LOS A	0.6	4.8	0.30	0.00	46.0
12	R	37	12.0	0.108	7.5	LOS A	0.6	4.8	0.30	0.72	42.7
Approach		174	12.0	0.108	3.3	NA	0.6	4.8	0.30	0.25	44.7
All Vehicles		437	12.0	0.108	4.3	NA	0.6	4.8	0.24	0.33	44.7

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: Sturt Highway Mayall Street
PM 2018 With Project

Four Way Town Centre Intersection
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mayall Street											
1	L	37	12.0	0.041	7.4	LOS A	0.1	1.0	0.24	0.58	42.5
2	T	33	12.0	0.076	9.2	LOS A	0.3	2.3	0.50	0.65	41.1
3	R	9	12.0	0.076	10.7	LOS A	0.3	2.3	0.50	0.77	40.3
Approach		79	12.0	0.076	8.5	LOS A	0.3	2.3	0.38	0.63	41.6
East: Sturt Highway											
4	L	12	12.0	0.067	6.7	LOS A	0.0	0.0	0.00	0.89	43.3
5	T	108	12.0	0.067	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
6	R	19	12.0	0.018	7.5	LOS A	0.1	0.5	0.26	0.58	42.3
Approach		139	12.0	0.067	1.6	NA	0.1	0.5	0.04	0.15	48.2
North: Mayall Street											
7	L	31	12.0	0.034	7.4	LOS A	0.1	0.9	0.25	0.58	42.4
8	T	21	12.0	0.091	9.8	LOS A	0.4	2.7	0.51	0.64	40.4
9	R	25	12.0	0.091	11.5	LOS A	0.4	2.7	0.51	0.79	39.6
Approach		77	12.0	0.091	9.4	LOS A	0.4	2.7	0.41	0.67	40.9
West: Sturt Highway											
10	L	37	12.0	0.112	7.3	LOS A	0.6	5.0	0.30	0.53	42.7
11	T	106	12.0	0.112	0.6	LOS A	0.6	5.0	0.30	0.00	45.9
12	R	37	12.0	0.112	7.5	LOS A	0.6	5.0	0.30	0.72	42.7
Approach		180	12.0	0.112	3.4	NA	0.6	5.0	0.30	0.26	44.6
All Vehicles		475	12.0	0.112	4.7	NA	0.6	5.0	0.25	0.36	44.4

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: Sturt Highway Mayall Street
PM 2020 Base

Four Way Town Centre Intersection
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mayall Street											
1	L	39	12.0	0.043	7.4	LOS A	0.1	1.1	0.24	0.58	42.4
2	T	27	12.0	0.067	9.2	LOS A	0.3	2.0	0.50	0.64	41.0
3	R	9	12.0	0.067	10.7	LOS A	0.3	2.0	0.50	0.76	40.3
Approach		76	12.0	0.067	8.5	LOS A	0.3	2.0	0.37	0.63	41.6
East: Sturt Highway											
4	L	13	12.0	0.070	6.7	LOS A	0.0	0.0	0.00	0.89	43.3
5	T	114	12.0	0.070	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
6	R	13	12.0	0.012	7.5	LOS A	0.0	0.3	0.26	0.58	42.3
Approach		139	12.0	0.070	1.3	NA	0.0	0.3	0.02	0.13	48.5
North: Mayall Street											
7	L	24	12.0	0.027	7.4	LOS A	0.1	0.7	0.25	0.58	42.4
8	T	15	12.0	0.069	9.8	LOS A	0.3	2.0	0.51	0.63	40.4
9	R	20	12.0	0.069	11.5	LOS A	0.3	2.0	0.51	0.78	39.6
Approach		59	12.0	0.069	9.4	LOS A	0.3	2.0	0.40	0.66	40.9
West: Sturt Highway											
10	L	32	12.0	0.113	7.4	LOS A	0.7	5.1	0.31	0.53	42.8
11	T	112	12.0	0.113	0.7	LOS A	0.7	5.1	0.31	0.00	45.9
12	R	39	12.0	0.113	7.6	LOS A	0.7	5.1	0.31	0.73	42.7
Approach		182	12.0	0.113	3.3	NA	0.7	5.1	0.31	0.25	44.6
All Vehicles		456	12.0	0.113	4.3	NA	0.7	5.1	0.24	0.33	44.7

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: Sturt Highway Mayall Street
PM 2020 With Project

Four Way Town Centre Intersection
Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Mayall Street											
1	L	39	12.0	0.043	7.4	LOS A	0.1	1.1	0.24	0.58	42.4
2	T	35	12.0	0.082	9.5	LOS A	0.3	2.5	0.51	0.66	40.8
3	R	9	12.0	0.082	10.9	LOS A	0.3	2.5	0.51	0.78	40.1
Approach		83	12.0	0.082	8.7	LOS A	0.3	2.5	0.39	0.64	41.5
East: Sturt Highway											
4	L	13	12.0	0.070	6.7	LOS A	0.0	0.0	0.00	0.89	43.3
5	T	114	12.0	0.070	0.0	LOS A	0.0	0.0	0.00	0.00	50.0
6	R	20	12.0	0.019	7.6	LOS A	0.1	0.5	0.27	0.59	42.2
Approach		146	12.0	0.070	1.6	NA	0.1	0.5	0.04	0.16	48.1
North: Mayall Street											
7	L	32	12.0	0.035	7.5	LOS A	0.1	0.9	0.25	0.59	42.4
8	T	22	12.0	0.101	10.1	LOS A	0.4	3.0	0.53	0.66	40.1
9	R	27	12.0	0.101	11.8	LOS A	0.4	3.0	0.53	0.81	39.3
Approach		81	12.0	0.101	9.7	LOS A	0.4	3.0	0.42	0.68	40.7
West: Sturt Highway											
10	L	39	12.0	0.118	7.4	LOS A	0.7	5.3	0.31	0.52	42.7
11	T	112	12.0	0.118	0.7	LOS A	0.7	5.3	0.31	0.00	45.8
12	R	39	12.0	0.118	7.6	LOS A	0.7	5.3	0.31	0.72	42.7
Approach		189	12.0	0.118	3.5	NA	0.7	5.3	0.31	0.26	44.5
All Vehicles		500	12.0	0.118	4.8	NA	0.7	5.3	0.26	0.36	44.3

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

Processed: Tuesday, 11 November 2014 4:48:01 PM
SIDRA INTERSECTION 5.1.13.2093
Project: C:\Program Files (x86)\SIDRA SOLUTIONS\SIDRA RESULTS\Iluka Balranald Intersections\Sturt Highway Mayall Street Intersection.sip
8001331, EMG, SINGLE

SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: Tooleybuc Bridge AM 2014

Tooleybuc Bridge Modelled as Give Way Intersection with 18 second gap requirement
Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Murray Street South											
1	L	2	18.0	0.009	13.9	LOS A	0.0	0.4	0.78	0.40	37.8
2	T	1	18.0	0.001	6.4	LOS A	0.0	0.0	0.25	0.47	43.4
Approach		3	18.0	0.009	11.4	LOS A	0.0	0.4	0.60	0.43	39.5
North: Mallee Highway North											
8	T	1	18.0	0.002	5.8	LOS A	0.0	0.0	0.12	0.48	44.0
9	R	40	18.0	0.057	9.1	LOS A	0.7	5.5	0.37	0.53	41.4
Approach		41	18.0	0.057	9.0	LOS A	0.7	5.5	0.36	0.52	41.5
West: Mallee Highway West											
10	L	39	18.0	0.041	10.5	LOS A	0.8	6.2	0.64	0.42	40.3
12	R	2	18.0	0.041	10.7	LOS A	0.8	6.2	0.64	0.44	40.2
Approach		41	18.0	0.041	10.5	NA	0.8	6.2	0.64	0.42	40.3
All Vehicles		85	18.0	0.057	9.8	NA	0.8	6.2	0.51	0.47	40.8

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: Tooleybuc Bridge AM 2018 Base

Tooleybuc Bridge Modelled as Give Way Intersection with 18 second gap requirement
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Murray Street South											
1	L	2	18.0	0.009	14.8	LOS B	0.0	0.4	0.81	0.41	37.2
2	T	1	18.0	0.001	6.5	LOS A	0.0	0.0	0.26	0.47	43.3
Approach		3	18.0	0.009	12.0	LOS A	0.0	0.4	0.63	0.43	39.0
North: Mallee Highway North											
8	T	1	18.0	0.002	5.8	LOS A	0.0	0.0	0.12	0.48	43.9
9	R	44	18.0	0.064	9.3	LOS A	0.8	6.2	0.39	0.52	41.2
Approach		45	18.0	0.064	9.3	LOS A	0.8	6.2	0.39	0.52	41.3
West: Mallee Highway West											
10	L	43	18.0	0.047	10.9	LOS A	0.9	7.0	0.68	0.43	39.9
12	R	2	18.0	0.047	11.1	LOS A	0.9	7.0	0.68	0.44	39.9
Approach		45	18.0	0.047	10.9	NA	0.9	7.0	0.68	0.43	39.9
All Vehicles		94	18.0	0.064	10.2	NA	0.9	7.0	0.53	0.47	40.5

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Tooleybuc Bridge AM 2018 With Project

Tooleybuc Bridge Modelled as Give Way Intersection with 18 second gap requirement
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Murray Street South											
1	L	2	18.0	0.010	17.5	LOS B	0.0	0.4	0.88	0.43	35.5
2	T	1	18.0	0.001	6.7	LOS A	0.0	0.0	0.30	0.48	43.2
Approach		3	18.0	0.010	13.9	LOS A	0.0	0.4	0.68	0.44	37.7
North: Mallee Highway North											
8	T	1	18.0	0.002	5.9	LOS A	0.0	0.0	0.14	0.48	43.9
9	R	56	18.0	0.083	9.9	LOS A	1.0	8.1	0.45	0.52	40.7
Approach		57	18.0	0.083	9.9	LOS A	1.0	8.1	0.44	0.52	40.8
West: Mallee Highway West											
10	L	55	18.0	0.063	12.2	LOS A	1.1	9.2	0.76	0.44	39.0
12	R	2	18.0	0.063	12.3	LOS A	1.1	9.2	0.76	0.44	39.0
Approach		57	18.0	0.063	12.2	NA	1.1	9.2	0.76	0.44	39.0
All Vehicles		117	18.0	0.083	11.1	NA	1.1	9.2	0.60	0.48	39.8

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: Tooleybuc Bridge AM 2020 Base

Tooleybuc Bridge Modelled as Give Way Intersection with 18 second gap requirement
Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Murray Street South											
1	L	2	18.0	0.009	15.3	LOS B	0.0	0.4	0.82	0.41	36.9
2	T	1	18.0	0.001	6.5	LOS A	0.0	0.0	0.27	0.47	43.3
Approach		3	18.0	0.009	12.4	LOS A	0.0	0.4	0.64	0.43	38.8
North: Mallee Highway North											
8	T	1	18.0	0.002	5.8	LOS A	0.0	0.0	0.13	0.48	43.9
9	R	46	18.0	0.067	9.4	LOS A	0.8	6.5	0.40	0.52	41.1
Approach		47	18.0	0.067	9.4	LOS A	0.8	6.5	0.40	0.52	41.2
West: Mallee Highway West											
10	L	45	18.0	0.050	11.1	LOS A	0.9	7.4	0.69	0.43	39.8
12	R	2	18.0	0.050	11.3	LOS A	0.9	7.4	0.69	0.44	39.7
Approach		47	18.0	0.050	11.1	NA	0.9	7.4	0.69	0.43	39.8
All Vehicles		98	18.0	0.067	10.3	NA	0.9	7.4	0.55	0.47	40.4

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

SIDRA INTERSECTION

MOVEMENT SUMMARY

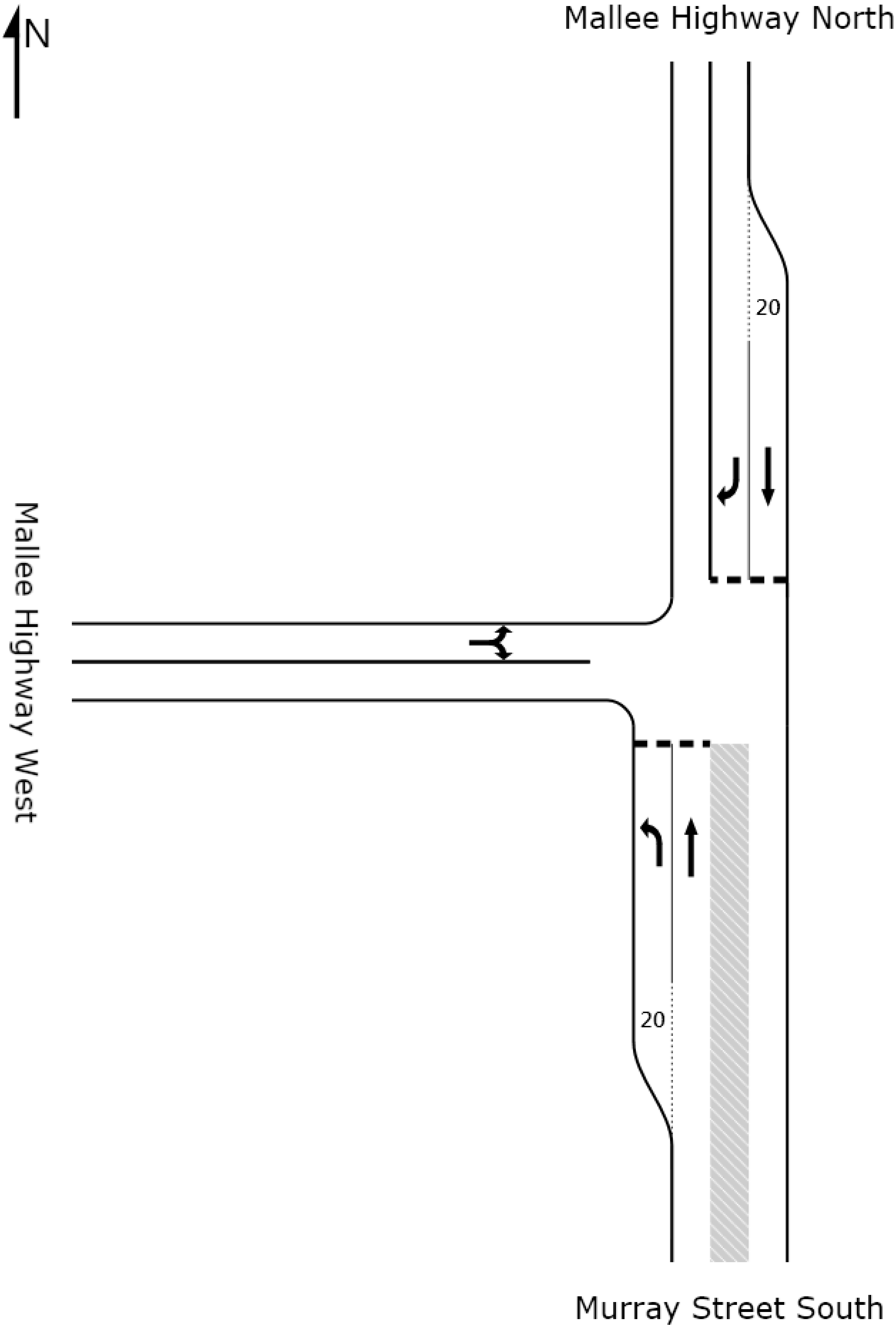
Site: Tooleybuc Bridge AM 2020 With Project

Tooleybuc Bridge Modelled as Give Way Intersection with 18 second gap requirement
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Murray Street South											
1	L	2	18.0	0.010	17.2	LOS B	0.0	0.4	0.87	0.42	35.6
2	T	1	18.0	0.001	6.7	LOS A	0.0	0.0	0.30	0.48	43.2
Approach		3	18.0	0.010	13.7	LOS A	0.0	0.4	0.68	0.44	37.8
North: Mallee Highway North											
8	T	1	18.0	0.002	5.9	LOS A	0.0	0.0	0.14	0.48	43.9
9	R	55	18.0	0.081	9.9	LOS A	1.0	7.9	0.44	0.52	40.8
Approach		56	18.0	0.081	9.8	LOS A	1.0	7.9	0.44	0.52	40.8
West: Mallee Highway West											
10	L	54	18.0	0.062	12.0	LOS A	1.1	9.0	0.75	0.43	39.1
12	R	2	18.0	0.062	12.2	LOS A	1.1	9.0	0.75	0.44	39.1
Approach		56	18.0	0.062	12.1	NA	1.1	9.0	0.75	0.43	39.1
All Vehicles		115	18.0	0.081	11.0	NA	1.1	9.0	0.60	0.48	39.9

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.


N
Mallee Highway North
20
Mallee Highway West
20
Murray Street South

MOVEMENT SUMMARY

Site: Tooleybuc Bridge PM 2014

Tooleybuc Bridge Modelled as Give Way Intersection with 18 second gap requirement

Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Murray Street South											
1	L	2	18.0	0.009	13.9	LOS A	0.0	0.4	0.78	0.40	37.8
2	T	1	18.0	0.001	6.4	LOS A	0.0	0.0	0.25	0.47	43.4
Approach		3	18.0	0.009	11.4	LOS A	0.0	0.4	0.60	0.43	39.5
North: Mallee Highway North											
8	T	1	18.0	0.002	5.8	LOS A	0.0	0.0	0.11	0.48	44.0
9	R	46	18.0	0.065	8.9	LOS A	0.8	6.3	0.34	0.53	41.6
Approach		47	18.0	0.065	8.8	LOS A	0.8	6.3	0.34	0.53	41.7
West: Mallee Highway West											
10	L	33	18.0	0.036	11.1	LOS A	0.7	5.4	0.69	0.42	39.8
12	R	2	18.0	0.036	11.3	LOS A	0.7	5.4	0.69	0.43	39.8
Approach		35	18.0	0.036	11.1	NA	0.7	5.4	0.69	0.42	39.8
All Vehicles		85	18.0	0.065	9.8	NA	0.8	6.3	0.49	0.48	40.8

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: Tooleybuc Bridge PM 2018 Base

Tooleybuc Bridge Modelled as Give Way Intersection with 18 second gap requirement

Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Murray Street South											
1	L	2	18.0	0.009	14.7	LOS B	0.0	0.4	0.80	0.41	37.2
2	T	1	18.0	0.001	6.5	LOS A	0.0	0.0	0.26	0.47	43.3
Approach		3	18.0	0.009	12.0	LOS A	0.0	0.4	0.62	0.43	39.1
North: Mallee Highway North											
8	T	1	18.0	0.002	5.8	LOS A	0.0	0.0	0.11	0.48	44.0
9	R	51	18.0	0.071	9.0	LOS A	0.9	7.0	0.36	0.53	41.5
Approach		52	18.0	0.071	9.0	LOS A	0.9	7.0	0.35	0.53	41.5
West: Mallee Highway West											
10	L	36	18.0	0.041	11.5	LOS A	0.7	5.9	0.72	0.42	39.5
12	R	2	18.0	0.041	11.7	LOS A	0.7	5.9	0.72	0.43	39.5
Approach		38	18.0	0.041	11.5	NA	0.7	5.9	0.72	0.42	39.5
All Vehicles		93	18.0	0.071	10.1	NA	0.9	7.0	0.51	0.48	40.6

Level of Service (LOS) Method: Delay (RTA NSW).

Vehicle movement LOS values are based on average delay per movement

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.

SIDRA Standard Delay Model used.

SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: Tooleybuc Bridge PM 2018 With Project

Tooleybuc Bridge Modelled as Give Way Intersection with 18 second gap requirement

Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Murray Street South											
1	L	2	18.0	0.010	17.4	LOS B	0.0	0.4	0.87	0.43	35.5
2	T	1	18.0	0.001	6.7	LOS A	0.0	0.0	0.30	0.48	43.2
Approach		3	18.0	0.010	13.8	LOS A	0.0	0.4	0.68	0.44	37.7
North: Mallee Highway North											
8	T	1	18.0	0.002	5.8	LOS A	0.0	0.0	0.13	0.48	43.9
9	R	62	18.0	0.090	9.6	LOS A	1.1	8.9	0.42	0.52	41.0
Approach		63	18.0	0.090	9.5	LOS A	1.1	8.9	0.41	0.52	41.0
West: Mallee Highway West											
10	L	47	18.0	0.057	12.8	LOS A	1.0	8.2	0.79	0.44	38.6
12	R	2	18.0	0.057	13.0	LOS A	1.0	8.2	0.79	0.45	38.6
Approach		49	18.0	0.057	12.8	NA	1.0	8.2	0.79	0.44	38.6
All Vehicles		116	18.0	0.090	11.0	NA	1.1	8.9	0.58	0.49	39.9

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: Tooleybuc Bridge PM 2020 Base

Tooleybuc Bridge Modelled as Give Way Intersection with 18 second gap requirement

Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Murray Street South											
1	L	2	18.0	0.009	15.3	LOS B	0.0	0.4	0.82	0.41	36.9
2	T	1	18.0	0.001	6.5	LOS A	0.0	0.0	0.27	0.47	43.3
Approach		3	18.0	0.009	12.4	LOS A	0.0	0.4	0.64	0.43	38.8
North: Mallee Highway North											
8	T	1	18.0	0.002	5.8	LOS A	0.0	0.0	0.11	0.48	44.0
9	R	54	18.0	0.076	9.1	LOS A	0.9	7.5	0.37	0.53	41.4
Approach		55	18.0	0.076	9.1	LOS A	0.9	7.5	0.37	0.53	41.4
West: Mallee Highway West											
10	L	38	18.0	0.044	11.8	LOS A	0.8	6.4	0.74	0.43	39.3
12	R	2	18.0	0.044	12.0	LOS A	0.8	6.4	0.74	0.44	39.2
Approach		40	18.0	0.044	11.8	NA	0.8	6.4	0.74	0.43	39.3
All Vehicles		98	18.0	0.076	10.3	NA	0.9	7.5	0.53	0.48	40.4

Level of Service (LOS) Method: Delay (RTA NSW).

Vehicle movement LOS values are based on average delay per movement

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.

SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Tooleybuc Bridge PM 2020 With Project

Tooleybuc Bridge Modelled as Give Way Intersection with 18 second gap requirement

Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Murray Street South											
1	L	2	18.0	0.010	17.2	LOS B	0.0	0.4	0.87	0.42	35.6
2	T	1	18.0	0.001	6.7	LOS A	0.0	0.0	0.30	0.48	43.2
Approach		3	18.0	0.010	13.7	LOS A	0.0	0.4	0.68	0.44	37.8
North: Mallee Highway North											
8	T	1	18.0	0.002	5.8	LOS A	0.0	0.0	0.13	0.48	43.9
9	R	62	18.0	0.090	9.6	LOS A	1.1	8.9	0.41	0.53	41.0
Approach		63	18.0	0.090	9.5	LOS A	1.1	8.9	0.41	0.52	41.1
West: Mallee Highway West											
10	L	46	18.0	0.056	12.8	LOS A	1.0	8.0	0.79	0.44	38.6
12	R	2	18.0	0.056	13.0	LOS A	1.0	8.0	0.79	0.44	38.6
Approach		48	18.0	0.056	12.8	NA	1.0	8.0	0.79	0.44	38.6
All Vehicles		115	18.0	0.090	11.0	NA	1.1	8.9	0.58	0.49	39.9

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

Appendix G

Austroads Intersection Standards

2.3.6 Warrants for BA, AU and CH Turn Treatments

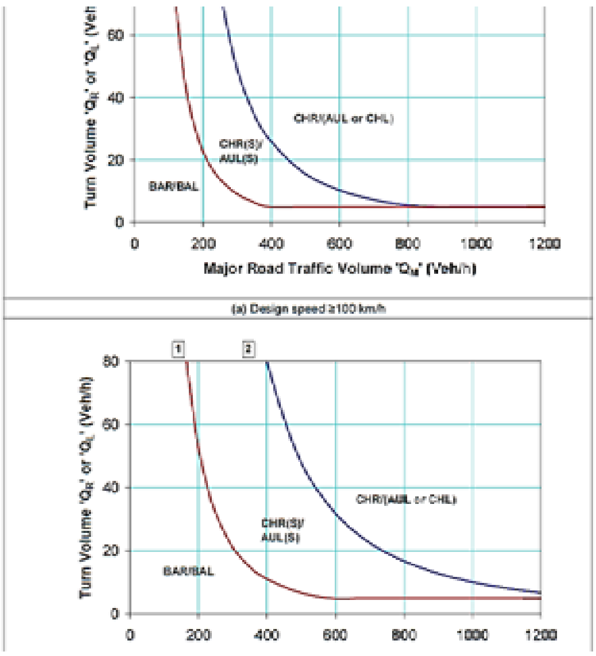
These warrants apply to major road turn treatments for the basic, auxiliary lane and channelised layouts discussed in Section 2.2.2, 2.2.3 and 2.2.4. The warrants are shown in Figure 2.23 and provide guidance on where a full-length deceleration lane must be used and where a shorter lane, designated AUL(S) and CHR(S), may be acceptable based on traffic volume. Figure 2.23 contains two graphs for the selection of turn treatments on roads with a design speed:

- greater than or equal to 100 km/h. Figure 2.23(a) is appropriate for high speed rural roads
- less than 100 km/h. Figure 2.23(b) is appropriate for urban roads, including those on the urban fringe and lower speed rural roads.

If a particular turn from a major road is associated with some geometric minima (for example, limited sight distance, steep grade), consideration should be given to the adoption of a turn treatment of a higher order than that indicated by the warrants. For example, if the warrants indicate that a BAR turn treatment is acceptable for the relevant traffic volumes, but limited visibility to the right-turning vehicle is available, consideration should be given to the adoption of a CHR(S) or CHR turn treatment instead. Another example is a major road on a short steep downgrade where numerous heavy vehicles travel quickly down the grade, in which case it would not be appropriate to adopt a BAL turn treatment. Instead, an AUL(S) or an AUL would be a preferred treatment.

Development of the warrants in this section is detailed in Arndt and Troutbeck (2006) and briefly discussed in Commentary 5.

[see Commentary 5]



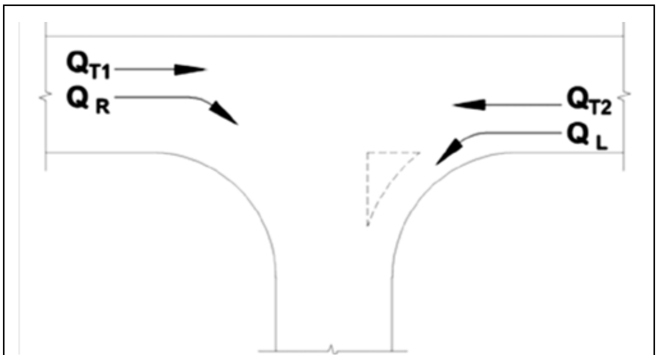
Source: Arndt and Troutbeck (2006).

Figure 2.23: Warrants for turn treatments on the major road at unsignalised intersections

In applying the warrants in Figure 2.23 designers should note that:

- Curve 1 represents the boundary between a BAR and a CHR(S) turn treatment and between a BAL and an AUL(S) turn treatment.

- Curve 2 represents the boundary between a CHR(S) and a CHR turn treatment and between an AUL(S) and an AUL or CHL turn treatment. The choice of CHL over an AUL will depend on factors such as the need to change the give way rule in favour of other manoeuvres at the intersection and the need to define more appropriately the driving path by reducing the area of bitumen surfacing.
- The warrants apply to turning movements from the major road only (the road with priority).
- Figure 2.24 is to be used to calculate the value of the major road traffic volume parameter (Q_M).
- Traffic flows applicable to the warrants are peak hour flows, with each vehicle counted as one unit (i.e. do not use equivalent passenger car units [pcus]). Where peak hour volumes or peak hour percentages are not available, assume that the design peak hour volume equals 8% to 10% of the AADT for urban situations and that the design hour volume equals 11% to 16% of AADT for rural situations.
- If more than 50% of the traffic approaching on a major road leg turns left or right, consideration needs to be given to possible realignment of the intersection to suit the major traffic movement. However, route continuity issues must also be considered (for example, realigning a highway to suit the major traffic movement into and out of a side road would be unlikely to meet driver expectation).
- If a turn is associated with other geometric minima, consideration should be given to the adoption of a turn treatment of a higher order than that indicated by the warrants.
- Some road authorities may consider that the CHR(S) treatment is not a suitable arrangement in all instances. Where this occurs, the Main Roads Western Australia AUR treatment may be used as an alternative (Part 4a of the *Guide to Road Design*, Austroads 2010). However the CHR(S) treatment is considered to be preferable for general use on major roads.
- Where the major road has four lanes (e.g. two in each direction) the value used for Q_M is the volume in the closest through lane to the turning movement.



Turn type	Splitter island	Q_M (veh/h)
Right	No	$= Q_{T1} + Q_{T2} + Q_L$
Right	Yes	$= Q_{T1} + Q_{T2}$
Left	Yes or no	$= Q_{T2}$

Source: Arndt and Troutbeck (2006).

Figure 2.24: Calculation of the major road traffic volume Q_M

7.3 Right-turn Bans at Signalised Intersections

Consideration should be given to banning a right turn where:

- a right-turn lane cannot be provided and the right-turning traffic would cause a safety and/or a capacity problem
- sight distance is poor and cannot be corrected, and other options such as erecting advance signs are not satisfactory.

If the right-turn can be banned, several options may be considered as described in Section 2.2.3 of the *Guide to Traffic Management – Part 6: Intersections, Interchanges and Crossings* (Austroads 2007) and illustrated in Section 4.14 of this guide.

7.4 Right-turn Lanes for Cyclists

Right-turn lanes for cyclists are rarely used and should generally not be provided for cyclists at right-turn treatments on arterial roads or busy traffic routes because of the difficulty and crash risk for cyclists moving from the left of an intersection to the centre of the road in order to utilise such treatments. Conditions for the use of cyclist right-turn lanes and illustrations of their use at an intersection are provided in Section 10.6.4 of this guide.

7.5 Rural Right-turn Treatments – Undivided Roads

All the turn treatments described in this section are applicable to two-lane two-way rural roads. They can also be applied to multi-lane rural roads (divided and, less commonly, undivided), except for the BAR turn treatment.

7.5.1 Rural Basic Right-turn Treatment (BAR)

The basic right-turn treatment (BAR) shown in Figure 7.5 is the minimum treatment for right-turn movements from a through road to side roads and local access points. This treatment provides sufficient trafficable width for the design through vehicle to pass on the left of a stationary turning vehicle. This is achieved by widening the shoulder to provide a minimum width sufficient to allow the vehicles to pass. Substantial speed reduction (potentially half of the design speed) is a feature of this layout.

Other aspects of the design are:

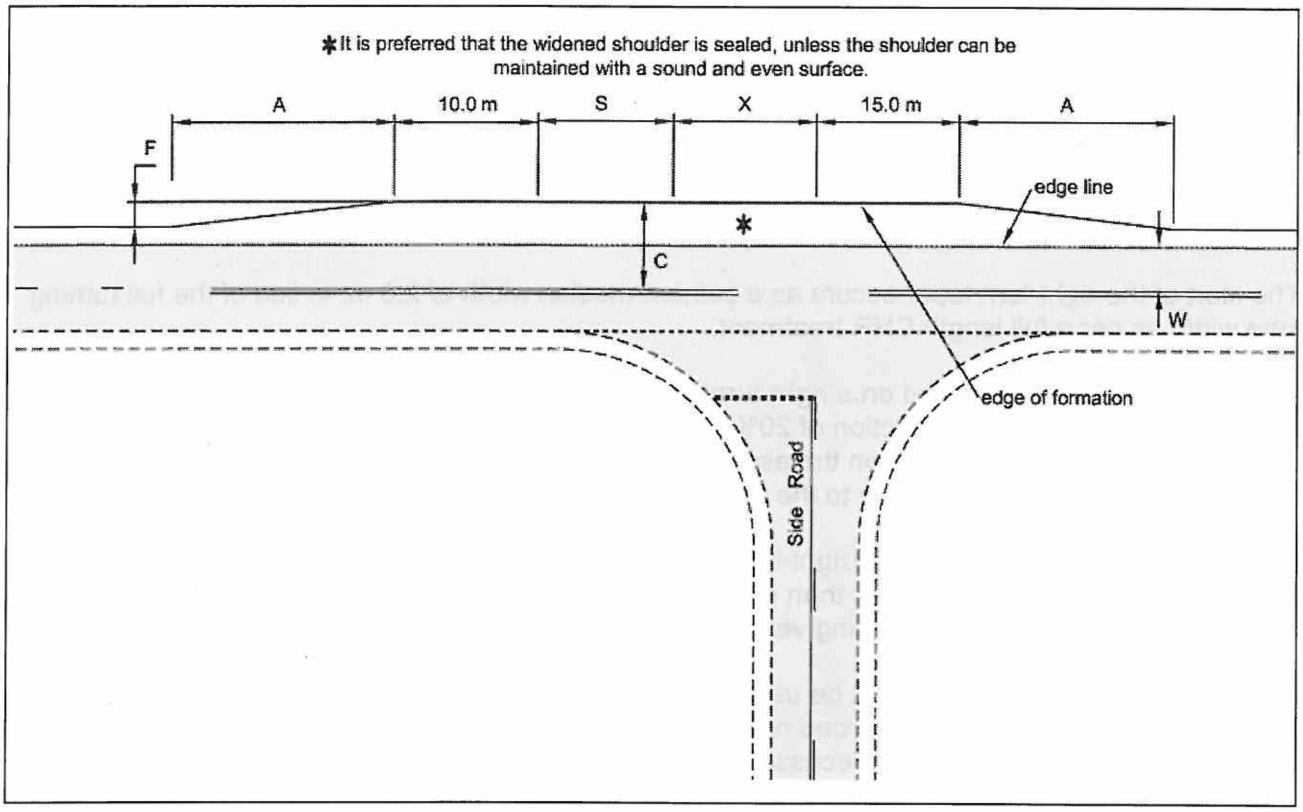
- on a terminating intersection leg no special provision is usually made for right-hand turns when a BAR is used
- this layout can be used on both sealed and unsealed roads
- it is preferred that the widened shoulder at BAR turn treatments is sealed, unless the shoulder can be maintained with a sound and even surface
- this layout should not be used where there is reduced visibility to the turn treatment. Right turning drivers on the major road need to perceive the location of the side road and stop if necessary in the through lane before the intersection.

Where adequate through sight distance exists, BAR turn treatments will generally be marked with a broken centreline to allow overtaking on the major road through the intersection. This will not restrict overtaking opportunities, thereby minimising delays. However, there may be instances where a BAR turn treatment on a section of road with good overtaking opportunities will yield a high likelihood of crashes resulting from inappropriate overtaking through the intersection. In such cases, a barrier line should be used. Examples of such instances include the following:

- The turn treatment is located after a significant length of roadway that has no overtaking opportunities. This geometry would result in drivers often overtaking through the intersection because of the large amount of time spent following other vehicles prior to the intersection. The increased exposure of overtaking may result in an excessively high overtaking-intersection vehicle crash rate.
- There are reasonably high right-turning volumes.
- The warrants dictate that a higher-level turn treatment is appropriate.

It is suggested that BAR treatments should generally have a barrier line on the major road approaches to reduce the likelihood of overtaking vehicles colliding with vehicles entering from the side road. Consideration should only be given to the use of a broken centreline in situations where overtaking opportunities are limited and the volume on the side road is very low.

The BAR turn treatment on a two-lane rural road as shown in Figure 7.5 has limited applications. It is mainly applicable at the junction of side roads and rural arterial roads with lower traffic volumes. Such turn treatments can record high crash rates, especially in high-speed areas. A more desirable treatment at such sites is a CHR(S) turn treatment discussed in Section 7.5.2.



Notes:

1. This treatment applies to the right turn from a major road to a minor road.
2. The dimensions of the treatment are defined thus:

W = Nominal through lane width (m) (including widening for curves). Width to be continuous through the intersection.

C = On straights – 6.5 m minimum

7.0 m minimum for Type 1 & Type 2 road trains

On curves – widths as above + curve widening (based on widening for the design turning vehicle plus widening for the design through vehicle).

A = $\frac{0.5VF}{3.6}$

Increase length A on tighter curves (e.g. those with a side friction demand greater than the maximum desirable). Where the design through vehicle is larger than or equal to a 19 m semi-trailer the minimum speed used to calculate A is 80 km/h.

V = Design speed of major road approach (km/h).

F = Formation/carriageway widening (m).

S = Storage length to cater for one design turning vehicle (m) (minimum length 12.5 m).

X = Distance based on design vehicle turning path, typically 10–15 m.

Source: QDMR (2006).

Figure 7.5: Basic right (BAR) turn treatment on a two-lane rural road

7.5.2 Rural Channelised T-junction – Short Lane Type CHR(S)

The CHR(S) turn treatment shown in Figure 7.6 is a more desirable treatment than the BAR treatment because it provides greater protection for vehicles waiting to turn right from the centre of the road. This treatment is suitable where there are low to moderate through and turning volumes. For higher volume sites, a full-length CHR turn treatment (Figure 7.7) is preferred.

This type of intersection can only be used with linemarking. It is not to be used with raised or depressed islands as the turn lane is short and it is desirable that right-turning drivers travel over the painted chevron to exit the through traffic stream as soon as possible.

For the CHR(S) turn treatment, all through traffic is required to deviate, hence the deviation must be designed to suit the operating speed. A minimum shoulder width of 1.0 m must be used on the through lane deviation.

The start of the right-turn taper occurs as a painted median width of 2.0 m, in lieu of the full turning lane width as per a full length CHR treatment.

The length of turn slot is based on a right-turning vehicle slowing to 80% of the design speed on the approach (i.e. a speed reduction of 20% in the through lane), prior to moving into the turn lane and decelerating. This is based on the assumption that drivers decelerate at a maximum value of 3.5 m/s^2 from the start of the taper to the start of the storage length.

Although some deceleration of the right-turning vehicles occurs in the through lane, this treatment records far fewer rear-end crashes than do BAR turn treatments. The good safety performance occurs by removing stationary turning vehicles from the through traffic stream.

CHR(S) turn treatments should not be used where there is reduced visibility to the turn treatment. Right-turning drivers on the major road need to perceive the location of the deceleration lane and the side road in time to make the necessary speed reduction in the through lane prior to diverging.

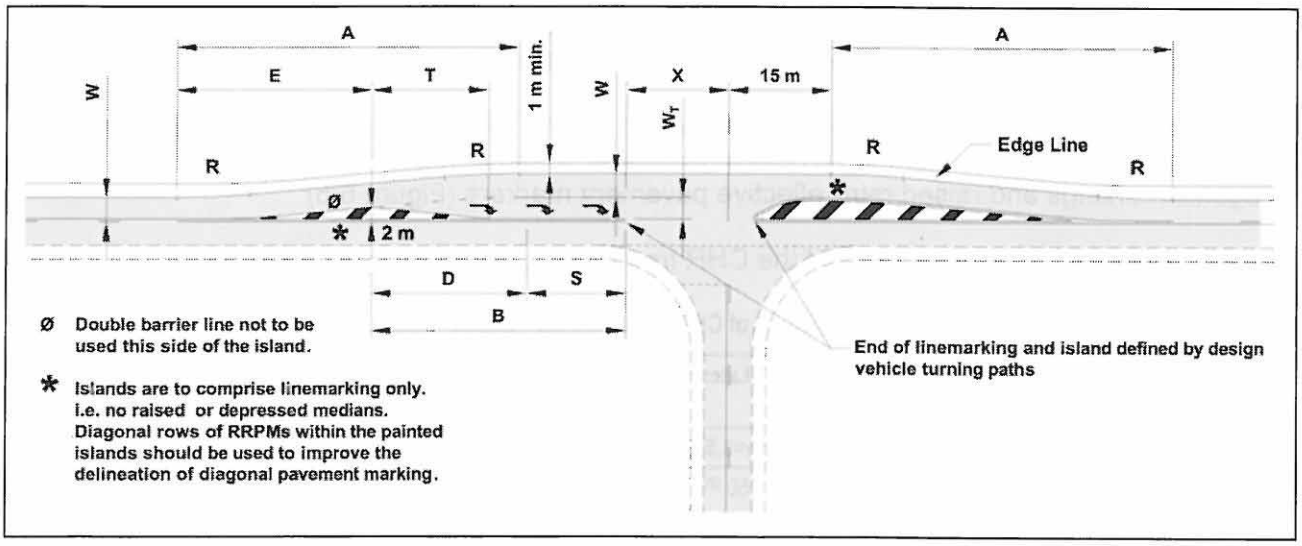
Table 7.1 provides the dimensions of the CHR(S) treatment for various design speeds.

Table 7.1: Dimensions of CHR(S) treatment for various design speeds

Design speed of major road approach (km/h)	Lateral movement length A (m)1	Diverge/ deceleration length D (m)2	Desirable radius R (m)	Taper length T (m)3
50	40[4]	15	110	15
60	50[4]	25	175	15
70	60	35	240	20
80	65	45	280	20
90	75	55	350	25
100	85	70	425	30
110	95	85	500	30
120	100	100	600	35

Notes:

1. Based on a diverge rate of 1m/sec and a turn lane width of 3.0 m. Increase lateral movement length if the turn lane width >3 m. If the through road is on a tight horizontal curve (e.g. one with a side friction demand greater than the maximum desirable), the lateral movement length should be increased so that a minimal decrease in speed is required for the through movement.
2. Based on a 20% reduction in through road speed at the start of the taper to a stopped condition using a value of deceleration of 3.5 m/s^2 (Table 5.2). Adjust for grade using the 'correction to grade' factor in Table 5.3.
3. Based on a turn lane width of 3.0 m.
4. Where Type 2 road trains are required, minimum A = 60 m.



Note: The dimensions of the treatment are defined below and values of A, D, R and T are shown in Table 7.1:

W = Nominal through lane width (m) (including widening for curves). For a new intersection on an existing road, the width is to be in accordance with the current link strategy.

W_T = Nominal width of turn lane (m), including widening for curves based on the design turning vehicle = 3.0 m minimum.

B = Total length of auxiliary lane including taper, diverge/deceleration and storage (m).

E = Distance from start of taper to 2.0 m width (m) and is given by:

$$E = 2\left(\frac{A}{W_T}\right)$$

T = Taper length (m) and is given by:

$$T = \frac{0.33xVxW_T}{3.6}$$

S = Storage length to cater for one design turning vehicle (m).

V = Design speed of major road approach (km/h).

X = Distance based on design vehicle turning path, typically 10–15 m.

Source: QDMR (2006).

Figure 7.6: Channelised right-turn treatment with a short turn slot [CHR(S)] two-lane rural road

7.5.3 Rural Channelised T-junction – Full Length (CHR)

For this layout, all traffic is required to deviate and therefore the road alignment for the through movement must be designed to suit the operating speed. This deviation requires the pavement to be widened to provide a full-length right-turn lane as shown in Figure 7.7.

The minimum lengths of deceleration (D) for different design speeds are shown in Table 5.2 and should be based on the comfortable deceleration rate of 2.5 m/s^2. The storage length (S) is usually determined through the use of computer programs such as aaSIDRA.

Details of the departure end of the right-turn lane should be determined using turning path templates (minimum radius 15.0 m). This will depend on the width and the angle of intersection of the road that the turning vehicle is entering.

There are no numerical warrants for the provision of raised medians in lieu of the painted medians, and some jurisdictions may require road lighting where raised medians are provided.

Pavement marking should be provided as shown in Figure 7.7. If the painted separation between opposing traffic flows is wider than a double white line, then the median should be delineated with diagonal markings and raised retroreflective pavement markers (Figure 6.5).

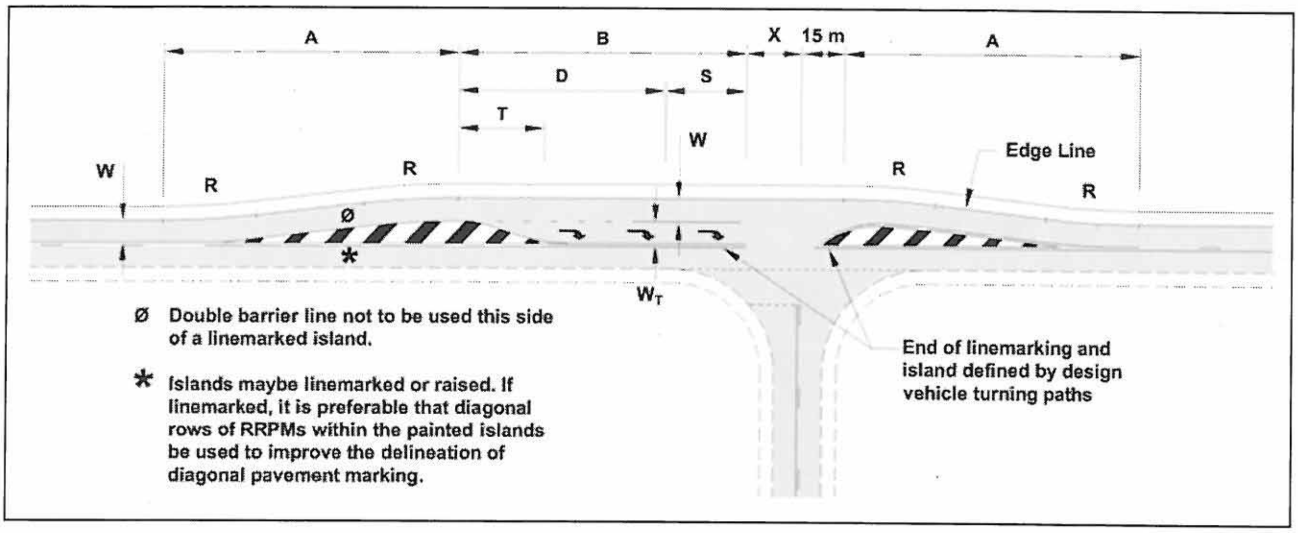
Table 7.2 provides the dimensions of the CHR treatment for various design speeds.

Table 7.2: Dimensions of CHR treatment for various design speeds

Design speed of major road approach (km/h)	Lateral movement length A (m) (1)		Desirable radius R (m)
	W_T=3.5 m	W_T=3.0 m	
50	50 (2)	40 (2)	110
60	60	50 (2)	175
70	70	60	240
80	80	65	280
90	90	75	350
100	100	85	425
110	110	95	500
120	120	100	600

Notes:

1. Based on a diverge rate of 1 m/sec. If the through road is on a tight horizontal curve (e.g. one with a side friction demand greater than the maximum desirable) increase the lateral movement length so that a minimal decrease in speed is required for the through movement.
2. Where Type 2 road trains are required minimum A = 60.0 m.



Notes:

1. An alternative to the double white line on the offside edge of the right-turn slot is a 1.0 m painted median. The 1.0 m median is particularly useful when the major road is on a tight horizontal curve and oncoming vehicles track across the centreline. Provision of this median will require the dimension 'A' to be increased.
2. A raised concrete median on the minor road may be used with this treatment to minimise 'corner cutting', particularly for higher turning volumes.
3. The dimensions of the treatment are defined below and values of A, D, R and T are shown in Table 7.2:

W = **Nominal through lane width (m) (including widening for curves). For a new intersection on an existing road, the width is to be in accordance with the current link strategy.**

W_T = **Nominal width of turn lane (m), including widening for curves based on the design turning vehicle. Desirable minimum = W, absolute minimum = 3.0 m.**

B = **Total length of auxiliary lane including taper, diverge/deceleration and storage (m).**

D = **Diverge/deceleration length including taper. Adjust for grade using the 'correction to grade' factor (Section 5)**

T = **Physical taper length (m) and is given by:**

$$T = \frac{0.33VW_T}{3.6}$$

S = **Storage length (m) should be the greater of:**

1. the length of one design turning vehicle or

2. (calculated car spaces –1) x 8 m (*Guide to Traffic Management – Part 3: Traffic Studies and Analysis* (Austroads 2009h), or use computer program e.g. aaSIDRA).

V = **Design speed of major road approach (km/h)**

X = **Distance based on design vehicle turning path, typically 10–15 m**

Source: Based on QDMR (2006).

Figure 7.7: Channelised right turn (CHR) on a two-lane rural road

7.5.4 Rural Right-Left Staggered T

Basic two-lane two-way road

This layout should be designed to ensure that:

- the stagger distance between the minor legs is large enough to discourage drivers from 'taking a short-cut on the wrong side of the traffic islands (e.g. at least 15 m to 25 m depending on the site characteristics)
- the island treatments in the minor roads are long enough to also discourage wrong way movements
- sufficient width is provided on the major road within the intersection to enable through vehicles to pass slowly to the left of vehicles waiting to turn right (e.g. 12 m), a similar principle to the BAR treatment.

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