F.2 Road safety report

YOUR NATIONAL TRANSPORT RESEARCH ORGANISATION

State Significant Development Road Safety Assessment Report

ARRB Project No.: 017134

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Prepared for: Gunlake Quarries

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Final Report

SUMMARY

The Australian Road Research Board (ARRB) was engaged by Gunlake Quarries (Gunlake) to undertake a road safety impact assessment for a State Significant Development (SSD) proposal for the quarry at Marulan, NSW.

Gunlake has previously undertaken a road safety and traffic impact assessment in 2017 for earlier quarry expansions. In response to the assessment, and in consultation with NSW Planning Assessment Commission, Goulburn-Mulwaree Shire Council and local residents, Gunlake implemented road safety upgrades on the Primary Transport Route, including road widening to accommodate a wide centreline and additional shoulder width, improvements at the quarry access road intersection on Brayton Road, and an acceleration lane at the Red Hills Road entry/exit on the Hume Highway.

Gunlake are seeking approval to increase heavy vehicle traffic movements along the Primary Transport Route to service growing market demand for quarry product. The *Gunlake Quarry Continuation Project* (Continuation Project) is an increase from the current approval of a maximum of 295 inbound and 295 outbound trucks and transporting up to 2.6 million tonnes per annum (mtpa) of saleable quarry products, to a maximum of 375 inbound and 375 outbound truck movements per day and transporting up to 4.2 mtpa of saleable quarry products.

From ARRB's review of the Primary Transport Route as it is currently configured, the impact of the proposed increase in heavy vehicle movements is assessed as follows:

- The impact on road safety for all road users is considered to be negligible, with an assessment concluding no major road safety hazards were identified which may result from the proposed increase in heavy vehicle volumes.
- The recorded crash history along the Primary Transport Route does not indicate an existing or developing road safety problem that would be made worse by the proposed increase in heavy vehicle traffic to/from the Gunlake Quarry.
- The road upgrades implemented following the previous SSD approval (practical completion August 2018) meet and exceed conditions of the current consent. Application of principles contained in relevant Austroads guidelines ensure existing cross-sections, road geometry and intersection geometry support the proposed additional heavy vehicle movements.
- Slow moving heavy vehicles have the potential to restrict light vehicle travel speeds along the uphill section of Ambrose Road. However, the light vehicle volume is low and the travel time delay that would be experienced by light vehicle drivers is relatively brief with overtaking opportunities available on the Hume Highway. Consequently, the provision of a climbing lane is not supported since the travel time and road safety impact is considered low and the cost and environmental impacts to provide the climbing lane would be significant.

The following actions are recommended to improve road safety along the Primary Transport Route:

- Widening to accommodate an extension of the wide centreline treatment and the approved typical cross-section through locations adjacent to major culverts to provide a consistent road treatment.
- T-intersection warning signage should be installed on each approach to the intersections of Ambrose/Brayton Road and the Ambrose/Red Hill Road.
- An inspection and renewal program should be set to ensure the deterioration in surface condition, line marking, guideposts, and other delineation, etc. is identified and addressed in a timely manner.

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CONTENTS

TABLES

FIGURES

1 INTRODUCTION

1.1 PROJECT BACKGROUND

The Australian Road Research Board (ARRB) was engaged by Gunlake Quarries Pty Ltd (Gunlake) to assess the road safety impact of a proposal to increase the volume of heavy vehicle traffic to and from a hard rock quarry located at 715 Brayton Road, Marulan, NSW. The proposed increase in heavy vehicle traffic is to meet increased market demand for material produced at the quarry under the current development consent.

Gunlake has previously engaged consultancies, including ARRB, to undertake road safety and traffic impact assessments as part of earlier expansion proposals of the quarry production. In response to those assessments, and in consultation with the NSW Planning Assessment Commission, Goulburn-Mulwaree Shire Council, and matters raised by local residents, Gunlake implemented road safety upgrades along the Primary Transport Route; these included road widening to accommodate a wide centreline treatment (WCLT) and additional sealed and unsealed shoulder width, intersection improvements at the entry to the Quarry on Brayton Road, and an acceleration lane along the Hume Highway to facilitate safer access via the State Highway.

A traffic impact assessment (TIA) of the potential effects of increased quarry truck movements on intersection level of service has been prepared by EMM (EMM 2021) as part of the Gunlake Quarry Continuation Project (Continuation Project). This TIA provides reference to the ARRB road safety assessment.

1.2 SCOPE OF ARRB REVIEW

This Road Safety Assessment Report covers the following quarry access routes:

- Brayton Road – south of the quarry entrance and north of the intersection with Ambrose Road.
- Ambrose Road – between Brayton Road and Red Hills Road.
- Red Hills Road – between Ambrose Road and the Hume Highway.

More detail on the quarry transport routes is provided in Section 2.

This assessment has considered the potential cumulative traffic impacts of the Continuation Project, particularly associated with heavy vehicle movements, and includes the following considerations:

- Road safety assessment along the Primary Transport Route
- Suitability of the existing road design, specifically:
  - road geometry
  - cross-section formation against Austroads design requirements
  - intersection design.
- Heavy vehicle climbing lane assessment along Ambrose Road.

1.3 REPORT STRUCTURE

The structure of this report is as follows:

- Section 1 – provides an overview of the project.
- Section 2 – outlines the quarry, relevant routes and proposed increase in traffic volume.
- Section 3 – details the assessment methodology.
- Section 4 – presents the findings of the road safety assessment.
- Section 5 – concludes the report and provides recommendations.

Along with the TIA, this report addresses the following traffic and transport components of the Secretary's Environment Assessment Requirements, issued on 6 May 2021:

- accurate predictions of the road traffic generated by the development, including a description of the types of vehicles likely to be used for transportation of quarry products – see TIA
- a detailed assessment of potential traffic impacts on the capacity, condition, safety, and efficiency of the local and State Road network (as identified above), including undertaking a road safety audit – addressed in this report and the TIA
- a description of the measures that would be implemented to mitigate any impacts – addressed in this report.

2 QUARRY DETAILS

2.1 TRANSPORT ROUTES

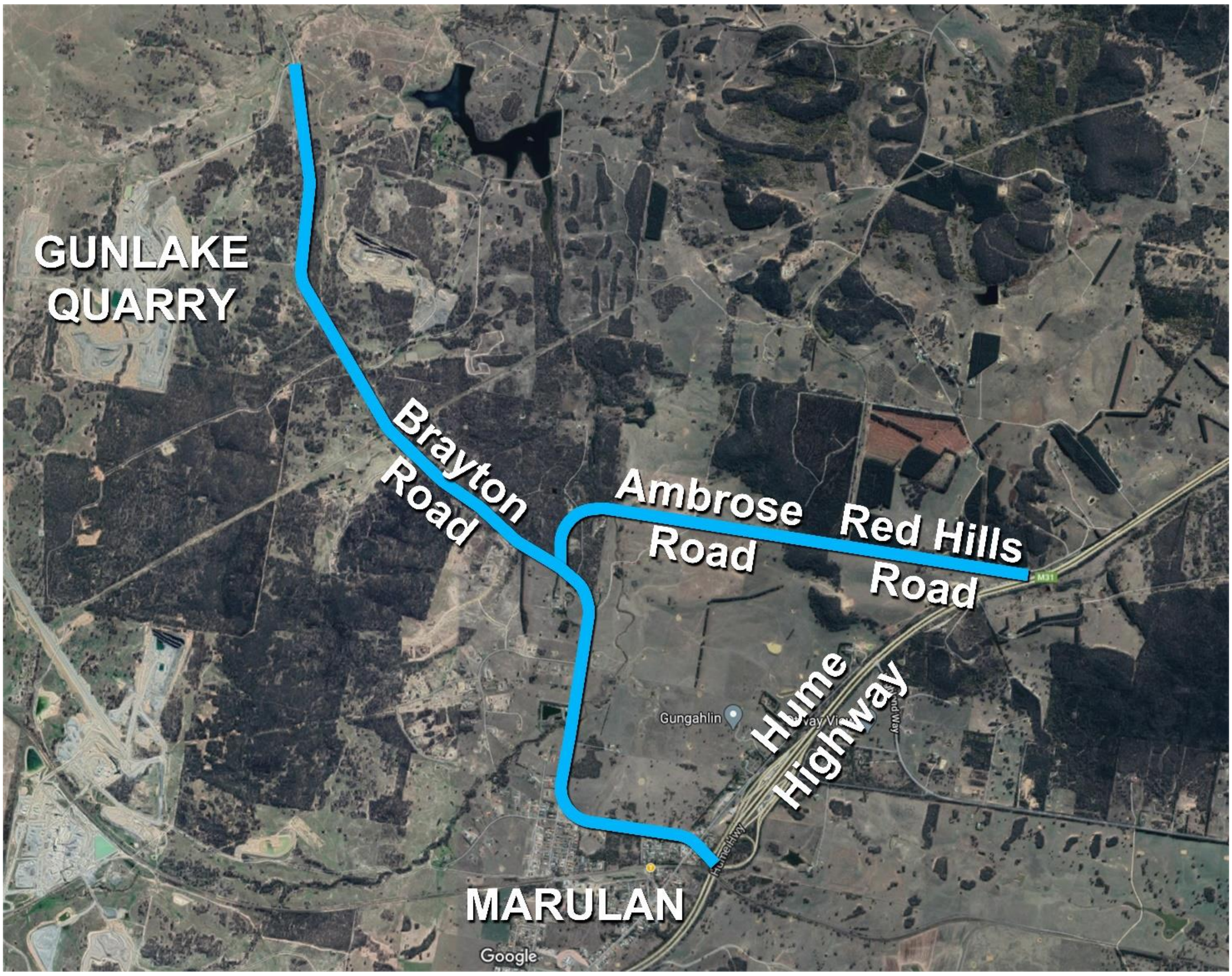
Depending on their origin and destination, heavy vehicles use the Gunlake Quarry at Marulan via either the defined Primary or Secondary Transport Route.

The Primary Transport Route accommodates travel to and from the Quarry access via Brayton Road, Ambrose Road and Red Hills Road, shown in Figure 2-1. The Primary Transport Route is used to transport all northbound product from the Quarry as well as all trucks returning to the Quarry.

The Secondary Transport Route, via Brayton Road and the Hume Highway on-ramp at Marulan, is only permitted for use to transport product to southbound destinations, noting heavy vehicles from the south must use the Primary Transport Route to access the quarry.

The roads along the Primary and Secondary Transport Routes are all local collector roads under the care and control of Goulburn-Mulwaree Shire Council.

Figure 2-1 Aerial view of Gunlake Quarry and subject roads



Source: Google Maps (2020)

The Primary Transport Route is approximately seven kilometres in length and is comprised of a series of long straights joined by large radii curves. The road is rural and undulating in nature, with one section of Ambrose Road having a long straight and moderate to steep incline section. The carriageway consists of one sealed travel lane in each direction separated by a wide centreline, sealed and unsealed shoulders, except where restricted by culverts and high-fill batters.

Sections of the route with restricted width typically have steel w - beam road safety barrier installed to redirect errant vehicles from leaving the carriageway.

A schematic diagram of a typical cross-section of the route is provided in Appendix A for information; a typical view of a wide centreline treatment section is shown in Figure 2-2.

Figure 2-2: Typical view of a wide centreline treated section of the Primary Transport Route

No speed limit signs are present along the Primary Transport Route; the default rural speed limit of 100 km/h therefore applies. As an additional road safety initiative, Gunlake has a driver code of conduct and driver induction outlining the requirement that all quarry trucks travel at a maximum speed of 80 km/h along the route, and actively monitor compliance.

2.2 SITE BACKGROUND

2.2.1 GUNLAKE QUARRY APPROVED EXTENSION PROJECT

In 2017, the current Gunlake Quarry extension project was approved by State Significant Development (SSD) 7090 by NSW Land and Environment Court (LEC) Approval 2017/108663. The current project approval was subsequently modified in 2021. The modified approval allows the Quarry to dispatch up to an average of 220 inbound and 220 outbound trucks per day, with a maximum of 295 inbound and 295 outbound trucks per day. In order to safely facilitate the increased number of heavy vehicle movements to and from the Quarry, several conditions of consent relating to road safety had to be met as part of the 2017 approval.

Table 2-1 outlines the conditions of consent relating to road safety and the response/action by Gunlake.

Table 2-1 2017 State Significant Development conditions of consent and Gunlake response

2017 SSD conditions of consent	Gunlake response/action
Upgrade the intersection of the quarry access road with Brayton Road in accordance with Austroads intersection design requirements by constructing an acceleration lane for truck traffic turning right from the quarry.	Intersection was upgraded to provide a 'seagull' intersection arrangement with a right turn deceleration into the Quarry and a right turn acceleration lane for heavy vehicles exiting the Quarry.
2 x 3.1 m marked traffic lanes.	Widening the road pavement to provide 2 x 3.25 m marked traffic lanes.
2 x 1.5 m wide shoulders with 0.5 m width sealed on each side.	Widening of the road pavement to provide 2 x 1.75 m shoulders with 1.25 m sealed.
3.0 m wide clear zones.	Minimum 3.0 m wide clear zones along sections where no road safety barrier is provided.
Double centreline and edgeline markings with retro-reflective pavement markers (rrpm).	A WCLT with edgelines and RRPMs installed.
Guideposts at spacings to suit the prevailing local fog conditions.	Guideposts were installed in accordance with Austroads guidelines.
Construct an additional 500 m long (including taper) left turn northbound acceleration lane at the intersection of Red Hills Road and the Hume Highway.	Intersection was upgraded to include an additional 500 m long acceleration lane in accordance with Austroads design guidelines.
Upgrade line-marking and signage along the Primary Transport Route by marking hidden driveways, upgrading line markings and increasing signage, and following discussions and agreement with Council, any upgrades required to improve school bus stop safety.	Signage and line marking along the route was installed in accordance with Austroads' guidelines and Australian Standards 1742, this included centreline (standard and wide) and edge line. Additional widening was provided at agreed bus stop locations with supplementary delineation, including yellow guideposts.

Since the LEC Approval was granted in 2017, the Primary Transport Route has, in consultation with Goulburn-Mulwaree Shire Council, been substantially upgraded to meet the requirements for a WCLT for rural roads with 1,000 to 3,000 average vehicle movements per day; from a road design cross-section and road safety risk perspective, this arrangement exceeds the requirements of the LEC Approval conditions.

Gunlake and Goulburn Mulwaree Council (Council) have implemented a road maintenance work plan and budget to ensure that the transport routes are appropriately maintained by Council using Gunlake Section 94 Contributions. Implementation of this arrangement ensures the condition and serviceability of the routes maintain the levels of road safety performance provided by the road upgrades.

The Primary Transport Route after implementation of works outlined in Table 2-1 are illustrated in the series of photographs in Figure 2-3.

Figure 2-3 Photographs of the Primary Transport Route after implementation of works

T-intersection Treatment – Quarry Access Road intersection with Brayton Road

Typical wide centreline treatment

Typical existing treatment near culvert sections

2.2.2 GUNLAKE QUARRY PROPOSED CONTINUATION PROJECT

Gunlake seeks a new development approval for the proposed Continuation Project that allows:

- a maximum of 375 inbound and 375 outbound daily truck movements with up to 4.2 million tonnes per annum (Mtpa) of saleable products transported from the site in any calendar year.
- a 30-year quarry life (from the date of Continuation Project approval).

EMM 2021 provided a summary of the key elements of the approved Extension Project compared to the Continuation Project. This table is provided in Table 2-2.

Table 2-2 Comparison of currently approved and proposed vehicular activity

Description	Currently approved	Proposed (continuation project)	Net increase
Maximum daily Quarry saleable product truck movements	295 outbound and 295 inbound movements	375 outbound and 375 inbound movements	80 outbound and 80 inbound movements
Maximum daily Quarry saleable product truck movements on Primary Transport Route	As above	As above	As above
Maximum daily Quarry saleable product truck movements on Secondary Transport Route	No more than 25 outbound trucks movements with a maximum of 38 per day	No change	No change
Quarry life	25 years to 30 June 2042	30 years (nominally to 2051)	9 years

Information provided by Gunlake indicates a maximum of 40 trucks will be loaded per hour at the Quarry as part of the Continuation Project; this translates to a maximum of 40 outbound trucks dispatched during a peak hour.

2.3 TRAFFIC SURVEY DATA

A traffic count and classification survey were conducted from 10 to 16 June 2020 at the following locations:

1. Brayton Road north of the intersection with Ambrose Road
2. Brayton Road south of the intersection with Ambrose Road
3. Ambrose Road between Brayton Road and Red Hills Road

A map of the traffic survey locations is provided in Figure 2-4.

Figure 2-4 Traffic survey locations

Source: Nearmap (2020)

Weekday averages of the traffic volume survey sites are summarised in Table 2-3.

Table 2-3 Summary of June 2020 traffic survey volumes

Survey location	East/Northbound			West/Southbound			Total (both directions)		
	Light vehicles	Heavy vehicles	Total 5-day AADT	Light vehicles	Heavy vehicles	Total 5-day AADT	Light vehicles	Heavy vehicles	Total 5-day AADT
1 – Primary	214	175 (45%)	**389**	246	150 (38%)	**396**	461	325	**786**
2 – Secondary	216	51 (19%)	**267**	267	43 (14%)	**310**	483	94	**577**
3 – Primary	85	118 (58%)	**203**	75	115 (60%)	**190**	160	232	**392**

Note: Light and heavy vehicle classes are as per the Austroads Vehicle Classification System illustrated in Appendix B.

Data provided by Gunlake Quarries shows a daily average of 126 heavy vehicles leaving the quarry in the week of the survey. It is estimated on average an equivalent number of heavy vehicles entered the quarry that week.

2.4 PROPOSED TRUCK MOVEMENTS

Gunlake are seeking approval for increased heavy vehicle movements along the Primary Transport Route in response to increased customer demand for quarry product. The number of truck movements is proposed to increase from a maximum of 295 inbound and 295 outbound truck movements to 375 inbound and 375 outbound truck movements per day, which is a net increase of 80 truck movements in each direction per day.

As the additional demand for the quarry product comes from northern markets, the projected increases in heavy vehicle volumes will be restricted to the Primary Transport Route. It is not proposed to increase heavy vehicle volumes on the Secondary Transport Route for the Continuation Project.

Table 2-4 provides an estimate of the current and proposed traffic volumes on the Primary and Secondary Transport Routes. The estimates are based on:

- Results of the traffic survey conducted in June 2020.
- Heavy vehicle counts provided by Gunlake Quarries.
- Routes used by inbound/outbound vehicles:
  - Primary used by northbound vehicles
  - Secondary used by southbound vehicles
  - Primary used by all inbound vehicles.

The following assumptions were made to support the estimation of traffic volumes:

- No proposed increase in heavy vehicle movements on the Secondary Transport Route.
- Annual growth in background traffic volume (i.e., excluding quarry related traffic volumes) is:
  - 0.5% per annum (pa) linear growth on arterial roads; and
  - 1% pa linear growth on local roads.
- Peak hour traffic is estimated to be 10% of the daily traffic volume.

Current traffic volumes excluding Gunlake Quarry heavy vehicles are calculated as the total vehicle volume from the traffic survey, less the average number of Gunlake Quarry vehicles entering and exiting the Quarry that week.

Table 2-4 Current and proposed traffic volumes per day (bidirectional)

Route	2020 Volumes[2]				2051 Volumes[3]			
	Light vehicles[1]	Heavy vehicles[1] (All)	Total	Gunlake (Approved)	Light vehicles	Heavy vehicles (Others)[4]	Gunlake (Maximum)[5]	Total
Brayton Road (Primary)	214	175	**389**	295	277	142	750	**1169**
Brayton Road (Secondary)	216	51	**254**	38	280	0	38	**318**
Ambrose Road and Red Hills Road (Primary)	203	118	**378**	295	160	263	750	**1125**

Note:

1. Light and heavy vehicle classes are as per the Austroads Vehicle Classification System illustrated in Appendix B
2. Actual classified tube counts – June 2020.
3. Project volumes applying the local roads annual growth figure (1%) on the 2020 actual counts.
4. Applying an estimate for daily truck traffic to/from non-Gunlake related locations and operations.
5. The maximum daily truck movements the subject of this Continuation Project application.

3 METHODOLOGY

This section outlines the methodology of the assessment for road safety, road design, and warrants for a climbing lane. All aspects of the assessment consider the effect of increased volume of heavy vehicles on the access routes, on road safety and road design requirements.

3.1 ROAD SAFETY

An assessment of road safety along the Primary Transport Route is largely a qualitative assessment, considering the road and roadside features in terms of the potential to contribute to road crashes and overall road safety risk. Reference is also made to relevant and established Austroads guidelines to ensure acceptable minimum road design criteria are met or exceeded.

Site inspection

ARRB undertook an inspection of the transport routes on 13 July 2021 and completed the following:

- Collected data, including video/photos of the site for this review and for future reference.
- Identified potential road safety risks, as potentially associated with the existing traffic arrangements and the proposed increase in heavy vehicle volume.
- Observed road user behaviour and existing traffic management infrastructure along the subject routes.

Desktop review

Relevant road design, road safety performance documentation, and video data were assessed by the project team to identify potential road safety issues which may arise from the proposed increase in heavy vehicle traffic volume.

Road Safety Audit

ARRB completed a Road Safety Audit (RSA) of the existing road conditions of the Gunlake Quarry Primary Transport Route. The observation and conclusions of this road safety audit informed the analysis presented in this report. A copy of the RSA is contained in Appendix C.

3.2 ROAD DESIGN

The previous assessment of the Primary and Secondary Transport Routes (ARRB 2020) considered the design elements of the road to optimise safety performance under the proposed traffic loading. The same process of review of design elements was undertaken to assess the increase in traffic volume compared to the latest best-practice for road cross-sections and design as outlined in *Austroads Guide to Road Design Part 3: Geometric Design* (2021).

More detail on the specifications in that Guide are provided in Appendix B.

3.3 CLIMBING LANE ASSESSMENT

The need for an auxiliary climbing lane to be installed on the steepest section of Ambrose Road eastbound was assessed against the requirements outlined in Austroads (2021).

Full details of the climbing lane assessment are outlined in Appendix B.

4 ASSESSMENT RESULTS

4.1 ROAD SAFETY

This section outlines the findings of the road safety assessment and road safety audit.

As there is no proposal by Gunlake to increase truck movements along the Secondary Transport Route, no adverse impact on road safety is expected from the Continuation Project.

4.1.1 GENERAL FINDINGS

A drive through review of the site with a follow up desktop assessment did not identify any notable or new road infrastructure safety hazards which may result from Gunlake's proposal to increase heavy vehicle traffic.

The upgrade of the Primary Transport Route as part of the current consent was undertaken to appropriately manage road safety risk for general and quarry-related traffic.

Key elements of the upgrade of the Primary Transport Route included the application of a WCLT to increase separation of opposing traffic streams, new and extended steel w-beam guardrail to prevent vehicles impacting roadside hazards and/or traversing steep embankments and culvert headwall drop-offs, clearing of roadside vegetation to provide a minimum 3.0 metre clear zone, provision of wide sealed and unsealed shoulders that provide drivers the opportunity to recover a drifting or errant vehicle, enhanced delineation with guideposts, line marking, and retro-reflective pavement markers, upgrade of the Quarry Entrance intersection on Brayton Road to improve vehicle separation and downstream merge arrangements, constructed roadside bus bays to permit public transport services (particularly school services) to move off the traffic lanes.

A review of these key elements, under increased traffic loading indicate they are expected to continue to mitigate foreseeable road safety risks. The typical WCLT and standard centreline formations along the Primary Transport Route are illustrated in Figure 4-1 and Figure 4-2, respectively.

Figure 4-1 Typical WCLT formation

Figure 4-2 Typical normal centreline formation

Currently, WCLTs have not been implemented in locations where major culverts are present along the Primary Transport Route, for example as shown in Figure 4-2. It is recommended these major culverts be extended and the road is widened and protected with guardrail to accommodate an extension of the wide centreline as per the typical cross section shown in Appendix A.

Due to the high environmental, property, and financial costs involved for a minimal road safety benefit, widening near and through the cutting on Ambrose Road to extend the WCLT is not supported.

Additional to the improvements listed above, Gunlake has implemented a corporate policy that restricts its heavy vehicle fleet to travelling a maximum of 80 km/h along the access routes (and lower where signposted). This acknowledges the effect that vehicle speed has on crash likelihood and severity outcome and the consequential and material effect of speed on the level of road safety risk along the route. Adopting a reduced maximum speed limit along the transport routes is an appropriate road safety risk management measure.

Conclusion: Key road safety hazards along the Primary Transport Route are appropriately managed and the level of road safety risk to road users is in the low to moderate range and is generally considered acceptable for a road of this type and traffic function.

The WCLT should be extended along sections where the road crosses major culverts, increasing the consistency of the road cross-section along the route and further mitigating road safety risk.

Delineation - Line marking, guideposts, signage and supplementary markers

Line marking is a key element of delineation which assists road users to identify the layout of the road ahead to reduce the incidence of run-off road crashes and to guide drivers during low-visibility and night-time conditions, and when approaching the rural intersections along the route.

Line marking and guideposts along the route are generally in a good condition, however gaps exist due to a degradation in condition at some locations, thus requiring routine maintenance to improve were noted. This leads to an inconsistency in guiding drivers along the route, sometimes at critical locations such as barrier terminals and on curves, especially in night-time and poor visibility conditions such as fog.

Poorly maintained delineation can cause inconsistency in guidance resulting in driver incorrectly interpreting or adapting to changing road conditions and alignment, potentially leading to loss of control and run-off road type crashes.

Deteriorating and faded line marking was identified during the site inspection and represents a road safety issue.

One factor in line marking durability is the effect of traffic, particularly at intersections where the ‘scrubbing’ action from the tyres of turning vehicles directly impacts line marking. Increased traffic volumes may increase the rate of deterioration of lines along the route, thus requiring more frequent inspection and renewal of the line marking to maintain effectiveness. Examples of faded line marking and degraded delineation along the Primary Transport Route are shown in Figure 4-3.

Figure 4-3 Examples of deteriorated assets

a) Intersection of Brayton Road and Ambrose Road

b) Gunlake Quarry access intersection

c) Ambrose Road (looking west)

d) Brayton Road (looking south)

Conclusion: Increased surveillance and maintenance of the along the Primary Transport Route is a key element to mitigating road safety risk. This includes improved maintenance of guideposts, line marking, and hazard marker signs (on barrier terminals), including cleaning, repair, and replacement as necessary to ensure drivers are provided the appropriate level of guidance along the route.

Road pavement condition (visual assessment)

A visual assessment of the road pavement surface shows it to be in a generally good condition with very few examples of unevenness, broken edges, potholes, shoves, etc. identified. There is evidence of some wear of the chip seal but nothing that is considered to present an elevated road safety risk.

A build-up of gravel was noted along sections of road as shown in Figure 4-4; this is typical especially in rural areas with aggregate generally coming from the road surface seal and roadside shoulders and requires sweeping maintenance to avoid obscuring line marking and creating a road safety hazard, especially for motorcyclists and cyclists.

In both instances, increased traffic volumes can exacerbate these adverse road surface conditions. Potentially increased monitoring and scheduled maintenance is considered sufficient to retain acceptable road safety performance.

Figure 4-4 Examples of build-up of gravel

a) Red Hill Road (looking west to Ambrose Road)

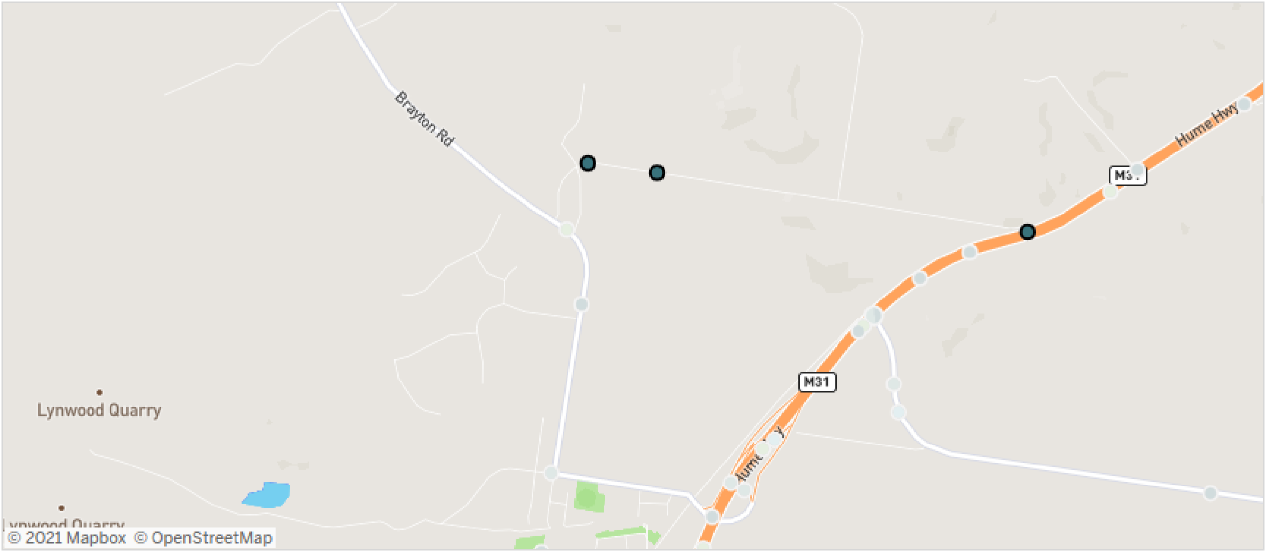
b) Red Hill Road (looking east)

Conclusion: The road pavement surface condition will likely be impacted by an increase in heavy vehicle volume. The routine inspection schedule should be reviewed by the responsible road authority to ensure an appropriate scheduled maintenance program is applied to address deterioration in a timely manner.

4.1.2 CRASH DATA

Crash data from Transport for NSW Centre for Road Safety indicates that over the five-year period from 2015 to 2019 there have been three crashes have been documented along the Primary Transport Route and two along the Secondary Transport Route. Summaries and maps of key crash features along the Primary Transport Route and two along the Secondary Transport Route are provided in Figure 4-5 and Figure 4-6 respectively.

Figure 4-5 Summary and map of crashes on the Primary Transport Route



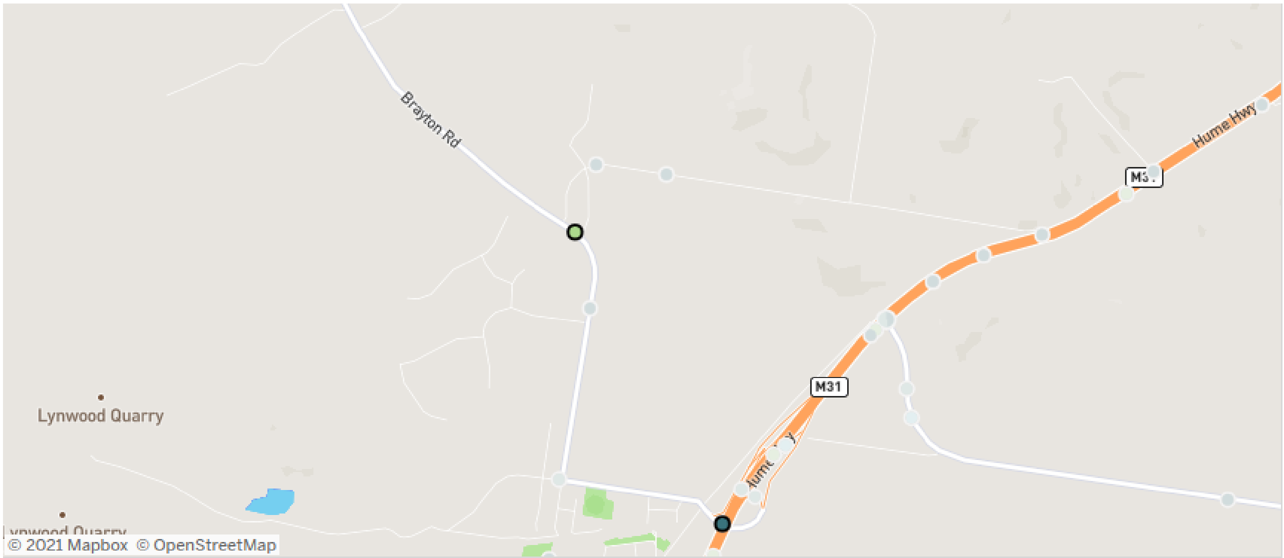
Degree of crash

Fatal | Serious Injury | Moderate Injury | Minor/Other Injury | Non-casualty (towaway)

Reporting ..	Crash ID	Degree of crash	RUM - code	RUM - description	Type of location	Natural lighting	Longitude	Lattitude	No Killed	No Injured
2016	1113381	Serious Injury	16	Left near	T-junction	Daylight	150.034614	-34.691651	-	3
2018	1161637	Serious Injury	74	On road-out of cont.	2-way undivided	Daylight	150.006647	-34.687969	-	1
2019	1200691	Serious Injury	82	Off right/right bend	2-way undivided	Daylight	150.001425	-34.687377	-	1

Source: Transport for NSW Centre for Road Safety

Figure 4-6 Summary and map of crashes on the Secondary Transport Route



Degree of crash

Fatal | Serious Injury | Moderate Injury | Minor/Other Injury | Non-casualty (towaway)

Reporting ..	Crash ID	Degree of crash	RUM - code	RUM - description	Type of location	Natural lighting	Longitude	Lattitude	No Killed	No Injured
2017	1150312	Non-casualty (t..	81	Off left/rt bnd=>obj	2-way undivided	Darkness	149.999831	-34.691496	-	-
2019	1200847	Serious Injury	33	Lane sideswipe	Divided road	Daylight	150.010812	-34.709336	-	3

Source: Transport for NSW Centre for Road Safety

Conclusion: None of the crashes on the Primary and Secondary Transport Routes in the 2015 to 2019 period related to Gunlake heavy vehicles. The recorded crash history along these Transport Routes do not indicate an existing or developing road safety problem that would be made worse by the proposed increase in heavy vehicle traffic to/from the Gunlake Quarry.

4.2 ROAD DESIGN

This section outlines the impact on increased heavy vehicle volumes on road design.

Cross-section

The projected increase in traffic arising from the proposal, when added to existing traffic along the Primary Transport Route, gives an estimated peak traffic daily volume of 1,191 vehicles per day on Brayton Road, and 1,138 vehicles per day along Ambrose and Red Hill Roads (as provided in Table 2-4), with a significant proportion of heavy vehicles.

Austroads (2021), provided in Appendix B, suggests typical formation widths for roads of different traffic volume bands. The projected peak daily traffic volume for the Primary Transport Route falls within the 1,000 to 3,000 vehicles per day (vpd) band; for this AADT Austroads suggests a road formation as follows:

- 2 x 3.5 m traffic lanes
- 2 x 2.0 m shoulders (to include 2 x 1.0 m sealed shoulders)
- Total formation width of 11.0 m (10.0 m sealed)

Development of an upgrade plan for the Primary Transport Route implemented by Gunlake Quarries in 2018 considered the opportunity to further improve safety through an innovative design measure that utilises a WCLT. The purpose of a WCLT is to increase the physical separation of opposing traffic, thus reducing the risk of high severity crashes along two-lane two-way undivided rural roads.

Austroads (2021) contains road WCLT cross-section design advice and specifications under both normal and extended design domain conditions. There are several constraints along the Primary Transport Route that limit the feasibility of adopting wider road formations and the full application of the WCLT measure. These include:

- remnant roadside vegetation and its environmental value
- large differences in ground/road levels meaning cut/fill works may extend into private property
- the presence of utility services such as gas and electricity along the roadside
- property entrances are already short with steep grades to the road
- restricted road widths limit locations where the school bus services can safely pull clear of the traffic lanes
- headwalls for large box and pipe culvert drainage infrastructure, which are located on the edge of the existing formation width.

The road formation design options for standard and WCLT arrangements are presented in Table 4-1; these are compared with the recommended typical formation width for the Primary Transport Route.

A schematic diagram of the typical existing (WCLT upgraded) cross-section is provided in Appendix A.

A WCLT of 1.0 m offers considerably greater separation of opposing traffic compared to cross-section arrangements that use a standard S1 dividing or BS/BB dividing barrier centreline, which are just 100 and 300 mm wide, respectively. Considering the constraints and the road safety risks previously identified, it is recommended that the WCLT formation under the extended design domain continue to be applied to the Primary Transport Route.

At certain locations, where the formation width of the Primary Transport Route is restricted by site constraints such as deep road cuttings, high non-traversable fill sections and large box or pipe culverts, widening the road formation to the recommended typical section is likely to be costly and will adversely impact adjacent private properties and roadside vegetation. In situations such as these, Austroads (2021) permits a reduction in width of the WCLT sections to utilise a standard narrow centreline with an appropriate transition from WCLT.

Table 4-1 Austroads standard and WCLT cross-sections

Design feature	Austroads				Primary Transport Route – existing formation
	Standard cross-section		WCLT		
	500 – 1000 vpd	1000 – 3000 vpd	Normal design domain[1]	Extended design domain	
Minimum length of WCLT (km)	n/a	n/a	2	2	7 km with selected narrowing
CLT width, centre of lines (m)	0.2	0.2	1.0	1.0	1.0
Lane width (m) (x2)	3.1	3.5	3.25	3.25	3.25
Sealed shoulder (m) (x2)	0.5	1.0	1.75	1.25	1.25
Shoulder width (m) (x2)	1.5	2.0	1.75	1.25	1.75
Unsealed shoulder (x2)	1.0	1.0	n/s	n/s	0.5[2]
Total sealed width (m)	7.2	9.0	11.0	10.0	10.0
Total formation width (m)	9.2	11.0	n/s	n/s	11.0

Note:

1. 'Normal design domain' and 'extended design domain' are similar to 'desirable minimum' and 'absolute minimum' design criteria, respectively.

2. A nominal 0.5 m unsealed shoulder width has been applied to the recommended formation width for the EDD WCLT. Austroads (2021) does not specify a width for unsealed shoulders for WCLT sections.

Sections of road along the Primary Transport Route with restrictions preventing full implementation of the WCLT are protected with roadside safety barriers. Unprotected earth batters have been typically constructed with a 1:6 slope and maximum of 1:4 to prevent vehicle rollover in the case of a run-off road crash.

Conclusion: The current WCLT road cross-section exceeds the requirements outlined in the Austroads guidelines. Extension of the WCLT to the reduced width sections across the major culverts will improve consistency in the road configuration and reduce the isolated road safety risk.

Road geometry

The Primary Transport Route is a TfNSW-approved, 26 m B-double route.

There is no proposed change to the classification of heavy vehicles being permitted to use the route as part of the proposed increase in heavy vehicle movements, therefore the road geometry can continue to support all proposed vehicle movements without modification.

Conclusion: No changes are required to the road geometry as a result of the proposed increase in heavy vehicle traffic.

Intersection geometry

The Primary Transport Route contains four key intersections:

- Gunlake Quarry access intersection
- Brayton Road and Ambrose Road intersection
- Ambrose Road and Red Hills Road intersection
- Red Hill Road and Hume Highway intersection.

As part of works conducted by Gunlake in 2018, intersection upgrades were implemented to support the use of Austroads Class 10 B-Double vehicles. This included consideration of acceleration and deceleration lanes, sight distance, turning (swept) paths, and general road safety measures.

Gunlake Quarry access intersection: The Gunlake Quarry access road intersection on Brayton Road was upgraded to provide a by-pass lane with a 'seagull' configuration for southbound traffic to pass heavy vehicles turning out of the Quarry and accelerating on the moderate upward grade in Brayton Road.

The WCLT along Brayton Road does not currently extend to the Quarry access road intersection, with typical separation of traffic applied by standard linemarking for a 'seagull' intersection arrangement. The increased heavy vehicle traffic entering/exiting the Quarry access road intersection on Brayton Road will increase the exposure to the potential for conflict between turning and through traffic. This is not expected to result in an unacceptable risk; however, improvements can be provided with minimal impact on site by extending the WCLT and increasing the width of the painted median separating the through and acceleration lanes.

Ambrose Road and Brayton Road intersection: The intersection of Ambrose Road and Brayton Road was designed to facilitate heavy vehicle swept paths and provides median separation on all three approaches, which enhances vehicle separation, prevents corner cutting by all traffic, and therefore slows turning speeds.

A recent review of the intersection identified sight line restrictions for drivers of light vehicles when exiting Ambrose Road looking to the south and the north. These restrictions impact light vehicle drivers observing other light vehicles; heavy vehicles approaching the intersection have a higher profile and so are readily observed.

Ambrose Road and Red Hill Road intersection: No major changes were made in 2018 at the intersection of Ambrose Road and Red Hill Road due to the very low number of light vehicles turning at the intersection and an absence of turning heavy vehicles at the intersection. Significant topographic constraints limit reasonable options for improvements.

A recent review of the intersection identified sight line restrictions for drivers of light vehicles when exiting Red Hill Road look to the east and west. These restrictions impact light vehicle drivers observing other light vehicles; heavy vehicles approaching the intersection are moving slowly and have a higher profile and so are readily observed.

Red Hill Road and Hume Highway intersection: Upgrades to the intersection of Red Hill Road and the Hume Highway included installation of an acceleration lane (in 2018) and deceleration lane (prior to 2018) on the Highway; lane widening on Red Hills Road and a median island to facilitate the sharp turn to/from the Highway has also been provided.

The EMM (2021) analysis indicates the heavy vehicle volume increase is not expected to impact the capacity of these lanes.

Conclusion: There is no proposed change to the classification of heavy vehicles being used on the route as part of the proposal; therefore, the intersection geometry at each of the intersection locations can support all proposed vehicle movements without modification.

The WCLT along Brayton Road should be extended to the Quarry access road intersection to improve vehicle separation and increase consistency of this treatment along the Primary Transport Route.

T-intersection warning signage on each approach to the Ambrose/Brayton Road and the Ambrose/Red Hill Road intersection will assist to advise approaching drivers of the presence of the intersection and potential for turning traffic.

4.3 CLIMBING LANE ASSESSMENT

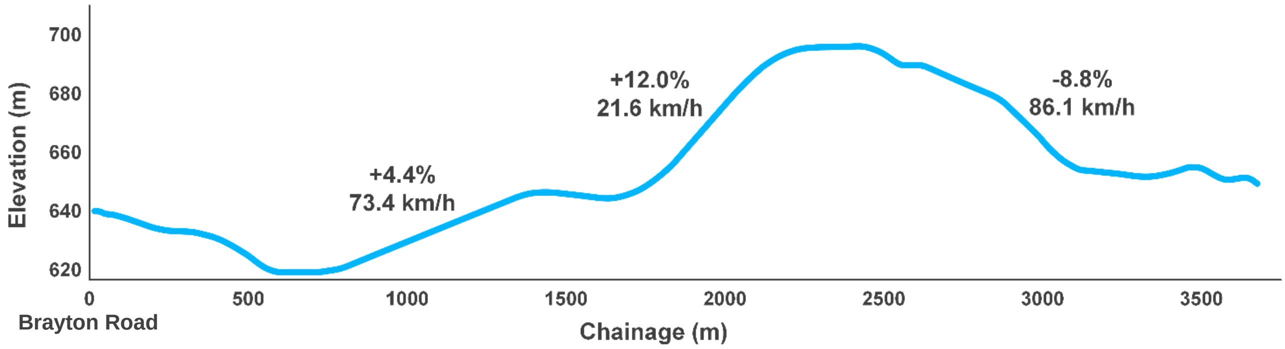
Existing situation

The longitudinal profile of Ambrose Road is shown in Figure 4-7.

Driving from west to east (i.e., trucks travelling from Brayton Road to the Hume Highway), Ambrose Road initially runs downhill at a maximum of 8% over a short length of approximately 240 m before crossing a causeway/culvert structure; the road then rises along a steady incline of 4% for approximately 600 m and then dips briefly before rising up a steep incline section of 12% for approximately 600 m. The road grade then levels off approaching the intersection with Red Hill Road, before running downhill at a variable grade, between 1.8 and 7.6%, to the Hume Highway. The road alignment is straight from the causeway culverts through to the Red Hills Road intersection and beyond to just prior to joining the Hume highway.

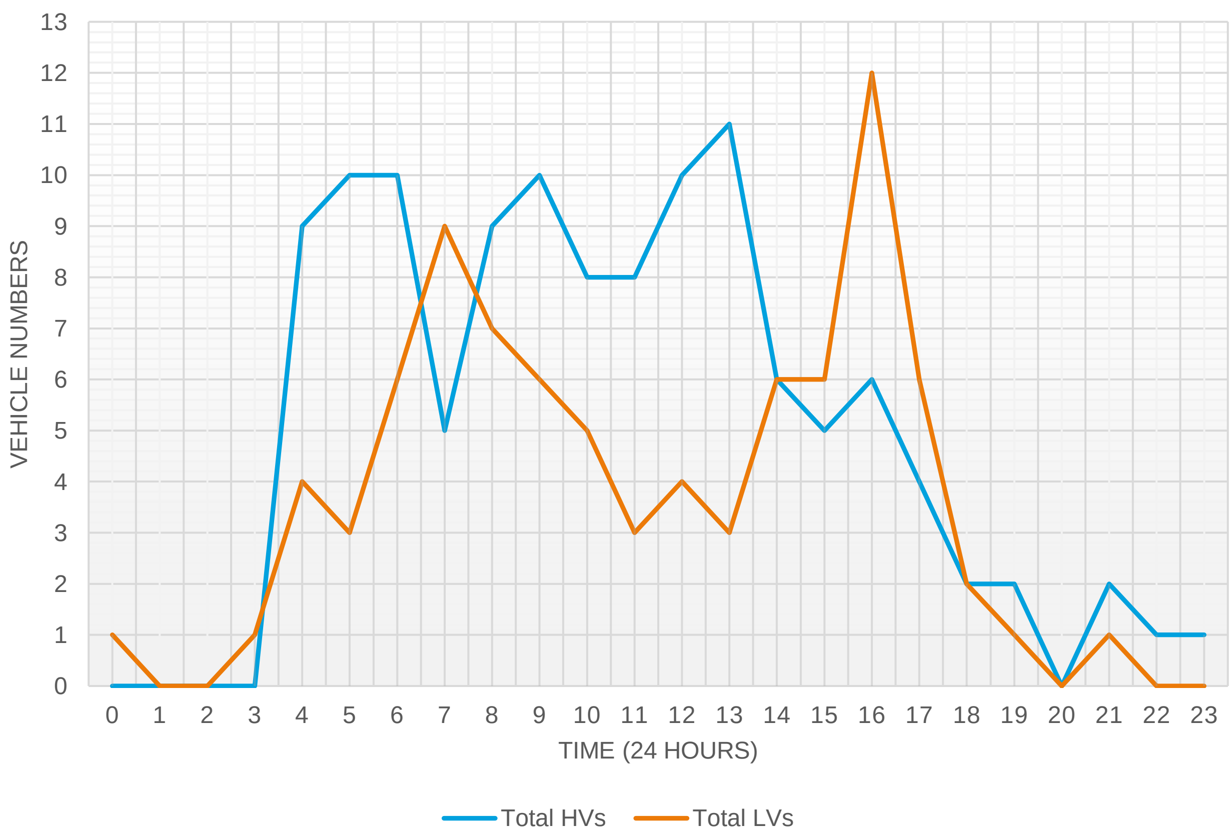
Average haul truck speed (based on truck telemetry data provided by Gunlake) and gradient at selected locations are indicated in Figure 4-7.

Figure 4-7 Ambrose Road and Red Hills Road gradient and average loaded haul truck speeds



The average weekday traffic flow along Ambrose Road, by vehicle type (light or heavy) and hour of day is plotted in Figure 4-8 for the existing situation.

Figure 4-8 Total light and heavy vehicle traffic volumes (weekday average by hour), June 2020



Key observations from the light and heavy traffic volumes include:

- The AM peak for light vehicle traffic occurs between 7.00 and 8.00 am with 9 cars recorded (an average of one vehicle every 6 – 7 minutes).

- A peak count of 10 heavy vehicles was recorded each hour between 5.00 and 6.00 am (an average of one heavy vehicle every 6 minutes).
- An average of 9 heavy vehicles per hour was recorded between 8.00 am and 2.00 pm (with a peak of 11 heavy vehicles at 1.00 pm); over the same period, an average of 5 light vehicles per hour was recorded.
- The peak of heavy vehicle traffic does not coincide with the peak of light vehicle traffic in the morning or during the day.

Proposed Gunlake Continuation Project

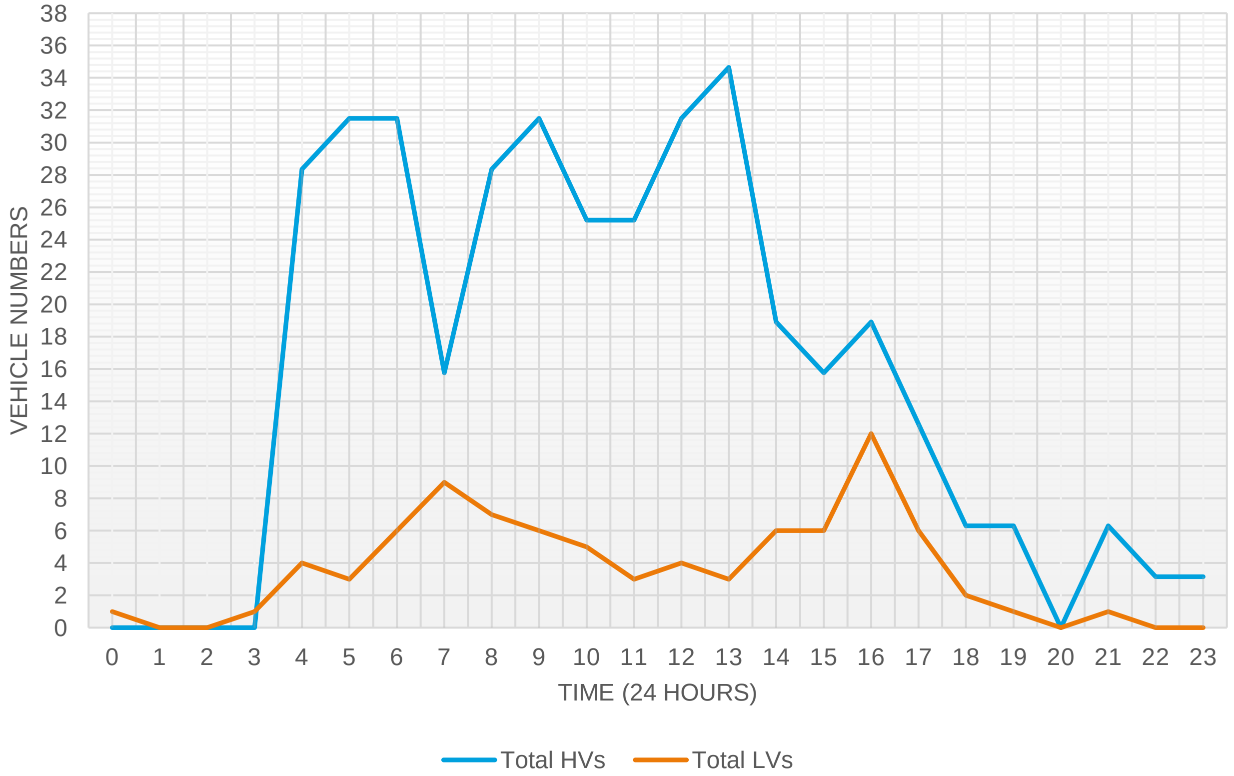
Under the proposed Continuation Project, the maximum heavy vehicle output from the Quarry is 40 trucks per hour.

Applying the maximum heavy vehicle output of the Quarry (i.e., 40 trucks per hour) to the traffic flow peaks identified in Figure 4-8 the following light/heavy vehicle conflicts are estimated as a worst-case scenario:

- Light vehicle morning peak 7.00 to 8.00 am:
  - Light vehicle count = 9 vehicles (one vehicle every 6 – 7 minutes)
  - Heavy vehicle maximum = 40 trucks (one truck every 2 minutes).
- Light vehicle afternoon peak 4.00 to 5.00 pm:
  - Light vehicle count = 12 vehicles (one vehicle every 5 minutes)
  - Heavy vehicle maximum = 40 trucks (one truck every 2 minutes) .

Applying similar patterns as currently exist, the peak of heavy vehicle traffic is not expected to coincide with the peak of light vehicle traffic in the morning or during the day. Therefore, disruption and delay caused to general traffic along the Primary Transport Route is expected to be relatively minor.

Figure 4-9 Total light and heavy vehicle traffic volumes (weekday average by hour), June 2020 for the Proposed Gunlake Continuation Project



Climbing lane warrants and review

The warrants for an overtaking or climbing lane consider multiple factors and are generally applied as a strategic view for longer length routes than that represented by the Primary Transport Route. An overtaking lane or climbing lane serves two purposes:

- Climbing lanes provide improved amenity, typically referred to as level of service (LoS) and provide improved traffic flow when faster vehicles are restrained by slower moving vehicles.
- Climbing lanes are provided to address road safety risk, which increases when safe overtaking opportunities are restricted due to road terrain and/or a lack of appropriate gaps in the opposing traffic stream.

Austroads (2021) provides a checklist of factors for considering if overtaking or climbing lanes are warranted based the road environment and LoS factors; Austroads (2020) provides additional guidance for determining the LoS along rural two-lane highways based on average travel speed; refer to Appendix B for details. The assessment of Ambrose Road against the LoS and Austroads warrants for a climbing lane is presented in Table 4-2.

Table 4-2 Climbing Lane assessment for Ambrose Road

Austroads warrant	Assessment	Comment
Truck speeds fall to 40 km/h or less	Yes	Trucks lose considerable speed as they approach the top of the incline, dropping to an average of 21.6 km/h near the top of the hill, based on truck telemetry data.
Traffic volumes equal or exceed those in Table 9.4 of Austroads 2020.	No	The significant proportion of heavy vehicles in the traffic flow along Ambrose Road exceeds the parameters of the Austroads warrant criteria (83% heavy vs. 17% light vehicles). Extrapolating the figures in Austroads Table 9.4 indicates the expected light vehicle volume on the route is well below the minimum value for the 'Very restricted' overtaking situation, estimated to be (in one direction): 80 vpd light vehicles and 378 vpd heavy vehicles (92% of 500 AADT)
Long grades over 8% occur	Yes, partial	Incline grade up to 12% extends for approximately 600 m
Accidents attributable to the effects of the slow-moving trucks are significant	No	No recorded crashes attributable to slow moving trucks.
Heavy trucks from an adjacent industry enter the traffic stream on the up grade	No	No heavy trucks enter on grade along this section of Ambrose Road.
Level of service on the grade falls two levels below that on the approach to the upgrade or to level 'E' AASHTO (2011a).	Yes, partial	• Speed surveys show 85th percentile speeds on approach to the incline section are 100 km/h indicating a LoS A. On the incline section, heavy vehicle speeds drop to as low as 21 km/h; light vehicles behind heavy vehicles on this section will experience LoS E. Following the climb, heavy vehicle speeds increase (>80 km/h), resulting in an improvement to LoS B through to the Hume Highway (a length of approximately 2.5 km), where safe overtaking is readily available to light vehicles once they enter the Highway. • Additional considerations in the assessment include the potential for light vehicles to be caught behind slow moving heavy vehicles. With reference to Figure 4-5, peaks in heavy vehicle traffic tend to occur during periods of low light vehicle volumes, discussed further below. Therefore, the likelihood of a delay to light vehicles behind a heavy vehicle is both low and, should it occur, of very short duration due to the distance to the Hume Highway after the incline section where overtaking opportunities are available.

A review of the Austroads climbing lane warrants suggests a climbing lane is potentially required to maintain appropriate LoS and safety along Ambrose Road.

However, to determine if there is sufficient benefit to justify an upgrade via the development of a climbing lane, further assessment of the potential and likely conflict between light and heavy vehicles, the effect of this on LoS, and the various impacts that developing a climbing lane may have, should be undertaken.

The following are additional points of consideration in the assessment of whether a climbing lane is necessary:

1. The construction of Ambrose Road was funded by Gunlake to remove the impact of heavy vehicle traffic to road users, residents, and businesses in Marulan; this includes improving the amenity and safety in the Marulan township by providing a safer alternative for heavy vehicle access to/from the Hume Highway.
2. The impact of slow-moving heavy vehicles on light vehicle travel along Ambrose Road occurs over a relatively short section and for a limited time of the incline. Speed surveys and telemetry data from heavy vehicles travelling the route indicates haul trucks can maintain operating speeds for the majority of the travel along Ambrose and Red Hills Roads.
3. Free-flow traffic conditions along the Hume Highway are less than 2 minutes east of the incline section of Ambrose Road, meaning the impact on travel time is minor over a typical journey.
4. The provision of a climbing lane would involve considerable cost associated with property acquisitions and largescale cut and fill earthworks to construct the additional lane; there would be additional environmental impact with the loss of roadside vegetation associated with the large cut and fill required.
5. The peak periods of heavy vehicle traffic flows do not coincide with the peak periods of light vehicle traffic flows. Considering the data plot presented in Figure 4-8 and Figure 4-9, very few light vehicles would be adversely impacted by the heavy vehicles travelling along Ambrose Road.

Conclusion: Slow moving heavy vehicles do have the potential to restrict light vehicle travel speeds along the uphill section of Ambrose Road. The proposed increase in heavy vehicle movements would increase the likelihood of light vehicles being ’held up’ until heavy vehicles are able to return to the road operating speed east of the Red Hill Road intersection.

However, the light vehicle volume is low and the travel time delay that would be experienced by light vehicle drivers is brief and occurs over a short length of the total journey along the Primary Transport Route; additionally, free flow conditions soon become available when joining the Hume Highway.

The provision of a climbing lane is not supported since the travel time and road safety impact is considered low and the cost and environmental impacts to provide the climbing lane significant.

5 CONCLUSIONS

The proposed increase in heavy vehicle movements to and from Gunlake Quarry at Marulan, NSW, has been assessed for impacts on road safety performance, road design, traffic amenity, and the need for a climbing lane. The impact of the proposed increase in heavy vehicle movements is assessed as follows:

- The impact on road safety for all road users is considered to be negligible, with an assessment concluding no major road safety hazards were identified which may result from the proposed increase in heavy vehicle volumes.
- The recorded crash history along the Primary Transport Route does not indicate an existing or developing road safety problem that would be made worse by the proposed increase in heavy vehicle traffic to/from the Gunlake Quarry.
- The road upgrades implemented following the previous SSD approval (practical completion August 2018) exceed conditions of consent. Application of principles contained in relevant Austroads guidelines ensure existing cross-sections, road geometry and intersection geometry support the proposed additional heavy vehicle movements.
- Slow moving heavy vehicles have the potential to restrict light vehicle travel speeds along the uphill section of Ambrose Road. However, the light vehicle volume is low and the travel time delay that would be experienced by light vehicle drivers is relatively brief with overtaking opportunities available on the Hume Highway. The provision of a climbing lane is not supported since the travel time and road safety impact is considered low and the cost and environmental impacts to provide the climbing lane significant.

The following actions are recommended to improve road safety along the Primary Transport Route:

- Widening to accommodate an extension of the wide centreline treatment and the approved typical cross-section through locations adjacent to major culverts to provide a consistent road treatment.
- T-intersection warning signage should be installed on each approach to the intersections of Ambrose/Brayton Road and the Ambrose/Red Hill Road.
- An inspection and renewal program should be set to ensure the deterioration in surface condition, line marking, guideposts, and other delineation, etc. is identified and addressed in a timely manner.

REFERENCES

AASHTO 2011a, A policy on geometric design of highways and streets, 5th edn, American Association of State Highway and Transportation Officials, Washington DC, USA

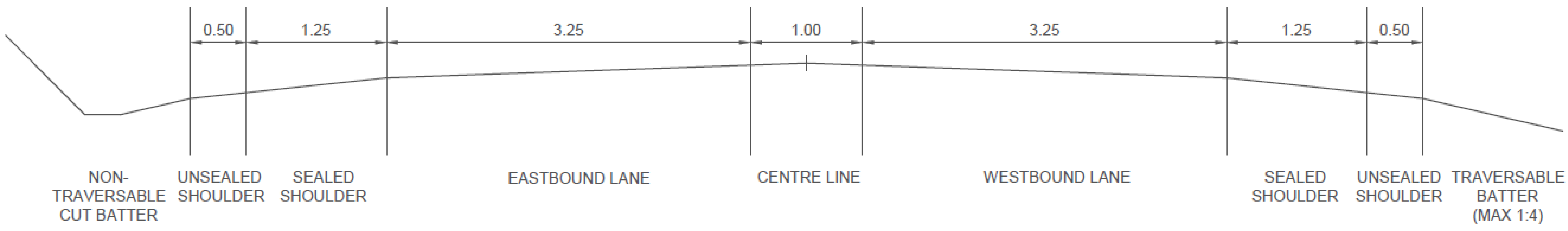
ARRB 2020, Road Safety Assessment, ARRB (016228), Sydney NSW.

Austroads 2020, *Guide to Traffic Management Part 3 Transport Study and Analysis Method*, AGTM03-20, Austroads, Sydney, NSW.

Austroads 2021, *Guide to Road Design Part 3 Geometric Design*, AGRD03-16, Austroads, Sydney, NSW.

EMM 2021, *Gunlake Quarry Continuation Project, Traffic Impact Assessment*, August 2021, EMM Consulting Pty Limited, Sydney, NSW

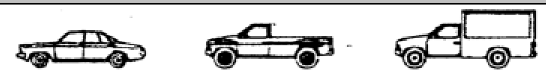
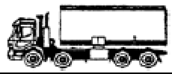
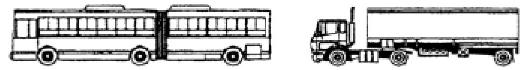
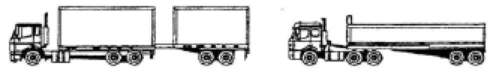
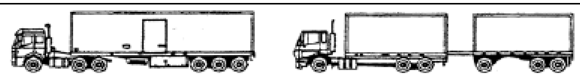
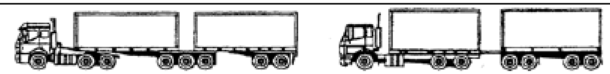
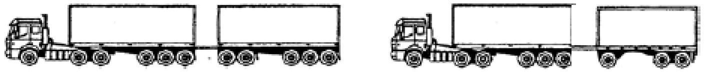
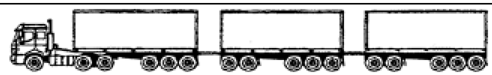
APPENDIX A TYPICAL CROSS-SECTION



APPENDIX B AUSTROADS REFERENCES

VEHICLE CLASSIFICATIONS

AUSTROADS Vehicle Classification System

Level 1 Length (indicative)	Level 2 Axles and Axle Groups		Level 3 Vehicle Type	AUSTROADS Classification		
Type	**Axles**	**Groups**	**Typical Description**	**Class**	**Parameters**	**Typical Configuration**
					LIGHT VEHICLES	
Short up to 5.5m		1 or 2	**Short** Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc	**1**	d(1) ≤ 3.2m and axles = 2	
Medium 5.5m to 14.5m	3, 4 or 5	3	**Short - Towing** Trailer, Caravan, Boat, etc	**2**	groups = 3 d(1) ≥ 2.1m, d(1) ≤ 3.2m, d(2) ≥ 2.1m and axles = 3, 4 or 5	
					HEAVY VEHICLES	
	2	2	**Two Axle Truck or Bus**	**3**	d(1) > 3.2m and axles = 2	
	3	2	**Three Axle Truck or Bus**	**4**	axles = 3 and groups = 2	
	> 3	2	**Four Axle Truck**	**5**	axles > 3 and groups = 2	
Long 11.5m to 19.0m	3	3	**Three Axle Articulated** Three axle articulated vehicle, or Rigid vehicle and trailer	**6**	d(1) > 3.2m, axles = 3 and groups = 3	
	4	> 2	**Four Axle Articulated** Four axle articulated vehicle, or Rigid vehicle and trailer	**7**	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 4 and groups > 2	
	5	> 2	**Five Axle Articulated** Five axle articulated vehicle, or Rigid vehicle and trailer	**8**	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 5 and groups > 2	
	≥ 6	> 2	**Six Axle Articulated** Six axle articulated vehicle, or Rigid vehicle and trailer	**9**	axles = 6 and groups > 2 or axles > 6 and groups = 3	
Medium Combination 17.5m to 36.5m	> 6	4	**B Double** B Double, or Heavy truck and trailer	**10**	groups = 4 and axles > 6	
	> 6	5 or 6	**Double Road Train** Double road train, or Medium articulated vehicle and one dog trailer (M.A.D.)	**11**	groups = 5 or 6 and axles > 6	
Large Combination Over 33.0m	> 6	> 6	**Triple Road Train** Triple road train, or Heavy truck and three trailers	**12**	groups > 6 and axles > 6	

Definitions:
Group: Axle group, where adjacent axles are less than 2.1m apart
Groups: Number of axle groups
Axles: Number of axles (maximum axle spacing of 10.0m)

d(1): Distance between first and second axle
d(2): Distance between second and third axle

ROAD DESIGN

The following tables have been taken from the Austroads Guide to Road Design Part 3 Geometric Design (2021). It provides the typical road formation arrangements of two lane two-way undivided rural roads.

Austroads extract – rural road widths

Table 4.5: Single carriageway rural road widths (m)

Element	Design AADT				
	1–150	150–500	500–1000	1000–3000	> 3000
Traffic lanes[1]	3.7 (1 x 3.7)	6.2 (2 x 3.1)	6.2–7.0 (2 x 3.1/3.5)	7.0 (2 x 3.5)	7.0 (2 x 3.5)
Total shoulder	2.5	1.5	1.5	2.0	2.5
Minimum shoulder seal [2],[3],[4],[5],[6]	0	0.5	0.5	1.0	1.5
Total carriageway	8.7	9.2	9.2–10.0	11.0	12.0

1 *Traffic lane widths include centrelines but are exclusive of edge-lines.*
2 *Where significant numbers of cyclists use the roadway, consideration should be given to fully sealing the shoulders. Suggest use of a maximum size 10 mm seal within a 20 km radius of towns.*
3 *Wider shoulder seals may be appropriate depending on requirements for maintenance costs, soil and climatic conditions or to accommodate the tracked width requirements for Large Combination Vehicles.*
4 *Short lengths of wider shoulder seal or lay-bys to be provided at suitable locations to provide for discretionary stops.*
5 *Full width shoulder seals may be appropriate adjacent to safety barriers and on the high side of superelevation.*
6 *A minimum 7.0 m seal should be provided on designated heavy vehicle routes (or where the AADT contains more than 15% heavy vehicles).*

Austroads extract – EDD for WCLT

Table F 2: Extended design domain (EDD) cross-section for a WCLT – two lane, two way roads

Design AADT	Vehicle routes	Sealed shoulder[2][3] (m)	Lane width[1] (m)	WCLT (m)	Total seal width (m)
2000–4000	All vehicles up to B-double	1.25	3.25	1.0	10.0
	Type 1 Road Train	1.00	3.50	1.0	
	Type 2 Road Train	1.00	3.75	1.0	10.5
> 4000	All vehicles up to B-double	1.25	3.25	1.0	10.0[4]
	Type 1 Road Train	1.00	3.50	1.0	
	Type 2 Road Train	1.00	3.75	1.0	10.5[4]
	All vehicles up to B-double	1.50	3.25	1.0	10.5
	Type 1 Road Train	1.25	3.50	1.0	
	Type 2 Road Train	1.25	3.75	1.0	11.0

1 *In situations with more than one lane in a single direction, the lane width is the same for all lanes.*
2 *In situations with an auxiliary lane, a sealed shoulder width of 1.0 m is often satisfactory. This width should be increased in areas of restricted visibility (e.g. around curves) and in the merge area at the end of the lane.*
3 *Total shoulder width of 2 m to 3 m generally provided of which the dimension in the tables is sealed.*
4 *These cross sections should only be used on roads in cuttings, or low embankments or where the batter slope does not exceed 1V:4H (desirably 1V:6H) – i.e. recoverable for cars. If roadside barriers are used, additional verge width should be applied when needed to accommodate the barrier.*

Source: Queensland Department of Transport and Main Roads (2015b).

CLIMBING LANE ASSESSMENT

Austroads extract – volume guidelines for overtaking and climbing lanes

Table 9.1: Traffic volume guidelines for providing overtaking lanes

Overtaking opportunities over the preceding 5 km[1]		Current-year design volume (AADT)		
		Percentage of slow vehicles[3]		
Description	Per cent length providing overtaking[2]	5	10	20
Excellent	70–100	5670	5000	4330
Good	30–70	4330	3670	3330
Moderate	10–30	3130	2800	2470
Occasional	5–10	2270	2000	1730
Restricted	0–5	1530	1330	1130
Very restricted[4]	0	930	800	670

1 *Depending on road length being evaluated, this distance could range from 3 to 10 km.*
2 *See Section 5.6.4.*
3 *Including light trucks and cars towing trailers, caravans and boats.*
4 *No overtaking for 3 km in each direction.*

Austroads extract – volume guidelines for partial climbing lanes

Table 9.4: Volume guidelines for partial climbing lanes

Overtaking opportunities over the preceding 5 km[1]		Current year design volume (AADT)		
		Percentage of slow vehicles[3]		
Description	Per cent length providing overtaking[2]	5%	10%	20%
Excellent	70–100	4500	4000	3500
Good	30–70	3500	3000	2600
Moderate	10–30	2500	2200	2000
Occasional	5–10	1800	1600	1400
Restricted	0–5	1200	1000	900
Very restricted[4]	0	700	600	500

1 *Depending on road length being considered, this distance can range from 3 to 10 km.*
2 *See Section 5.6.4.*
3 *Including light trucks and cars towing trailers, caravans and boats.*
4 *No overtaking for 3 km in either direction.*

Austroads (2021) identifies climbing lanes as a subset of auxiliary lanes, and in considering the need for them (auxiliary lanes) states:

- Auxiliary lanes are those lanes which are added adjacent to the through traffic lanes to enhance traffic flow and maintain the required level of service on the road.
- Auxiliary lanes are used to remove traffic that is causing disruption to the smooth flow of traffic in the through lanes to a separate lane to allow the through traffic to proceed relatively unhindered by the disruption. They are a means of separating the elements of the traffic stream on the basis of the speed difference between them, thereby improving the safety of the road as well as its capacity and level of service provided.

Options available in Austroads (2021) for auxiliary lanes include:

- Speed change lanes (acceleration and deceleration).
- Overtaking lanes and climbing lane.
- Slow vehicle turnouts.

For overtaking lanes, Austroads (2021) states:

- Overtaking lanes are provided to break up bunches of traffic and improve traffic flow over a section of road. They provide a positive overtaking opportunity and are sometimes the only real chance for overtaking to occur.
- The demand for overtaking occurs each time a vehicle catches up with another and the driver wishes to maintain the speed of travel. Provided there is no approaching traffic, this manoeuvre can occur where there is adequate sight distance.
- In extreme no-overtaking situations, very long queues can develop behind the slowest vehicles in the traffic stream. The delay and frustration experienced on grades may be greater due to the slow speed of travel. The proportion of the journey time spent following in bunches is a useful measure of quality of service as seen by the driver.
  The type of slow vehicle influences the nature of overtaking demand. Some vehicles can be overtaken easily anywhere along a route, while for others an upgraded overtaking opportunity is desirable. In evaluating the need for auxiliary lanes, attention should be given to the type of slow vehicles involved and whether the overtaking demand is continuous along a route or confined to specific problem locations.
  Types of slow vehicles are:
  - Vehicles with fairly high speeds, that slow down markedly on grades
  - Vehicles with low speeds, not affected by grades
  - Vehicles with average speeds that are seen as slow by those wishing to travel faster.

Austroads (2021) identifies:

- On two-lane two-way roads, the availability of overtaking opportunities depends on sight distance and gaps in the opposing traffic stream. As opposing traffic volume increases, overtaking opportunities become restricted even if sight distance is adequate. Sight distance that appears adequate may also be unusable on occasions due to the size of the vehicle in front, particularly on left-hand curves.
- In deciding whether an overtaking lane is warranted, the evaluation needs to be carried out over a significant route length and not be isolated to the particular length over which the additional lane may be constructed.
- The basis for adopting an overtaking lane is the traffic volume, the percentage of slow vehicles including light trucks and cars towing, and the availability of overtaking opportunities on adjoining sections.

Regarding climbing lanes, Austroads (2021) identifies:

- Climbing lanes can be considered as a special form of overtaking lane but they are only provided on inclines. Where they are provided, they form part of the network of overtaking opportunities and will therefore have an effect on decisions on the location of other overtaking lanes.
- The decision on whether to add a climbing lane is based ***on level of service considerations only*** (emphasis added).

It is these considerations that have been referenced in reviewing the need for an auxiliary/climbing lane.

Warrants

The warrants for each type of auxiliary lane are outlined in Austroads (2021).

Considering climbing lane options, Austroads (2021) states *'the decision on whether to add a climbing lane is based on level of service considerations only'*. On this basis, Austroads indicates that climbing lanes are warranted where:

- Truck speeds fall to 40 km/h or less
- Traffic volumes equal or exceed those in Table 9.4 of Austroads (2021), below.

and should be considered where:

- Long grades of over 8% occur
- Accidents attributable to the effects of the slow-moving trucks are significant

- Heavy trucks from an adjacent industry enter the traffic stream on the upgrade
- The level of service on the grade falls two levels below that on the approach to the upgrade or to level 'E' AASHTO (2011a).

LEVEL OF SERVICE

Austroads extract – automobile LOS for two-lane highways

LOS	Class I highway		Class II highways PTSF (%)	Class III highways PFFS (%)
	Average travel speed ATS (km/h)	Per cent time-spent-following (PTSF) (%)		
A	> 90	≤ 35	< 40	> 91.7
B	> 80 – 90	> 35 – 50	> 40 – 55	> 83.3 – 91.7
C	> 70 – 80	> 50 – 65	> 55 – 70	> 75.0 – 83.3
D	> 60 – 70	> 65 – 80	> 70 – 85	> 66.7 – 75.0
E	≤ 60	> 80	> 85	≤ 66.7

Note: LOS F applies whenever the arrival flow exceeds the segment capacity.

APPENDIX C ROAD SAFETY AUDIT REPORT

YOUR NATIONAL TRANSPORT RESEARCH ORGANISATION

Gunlake Quarry Primary Transport Route – Road Safety Audit

ARRB Project No.: 017134

Author: David McTiernan, Noha Elazar, Sonia Roberts & Mick Timms

Prepared for: Gunlake Quarries P/L

14 September 2021

Final

Version Control

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Contents

Tables

Figures

1 Introduction

1.1 PROJECT BACKGROUND

The Australian Road Research Board (ARRB) were engaged by Gunlake Quarries to undertake a roadsafety audit of the three road links – Brayton Road, Ambrose Road and Red Hill Road – that form the primary transport route for the transport of saleable products between the Marulan quarry and the Hume Highway.

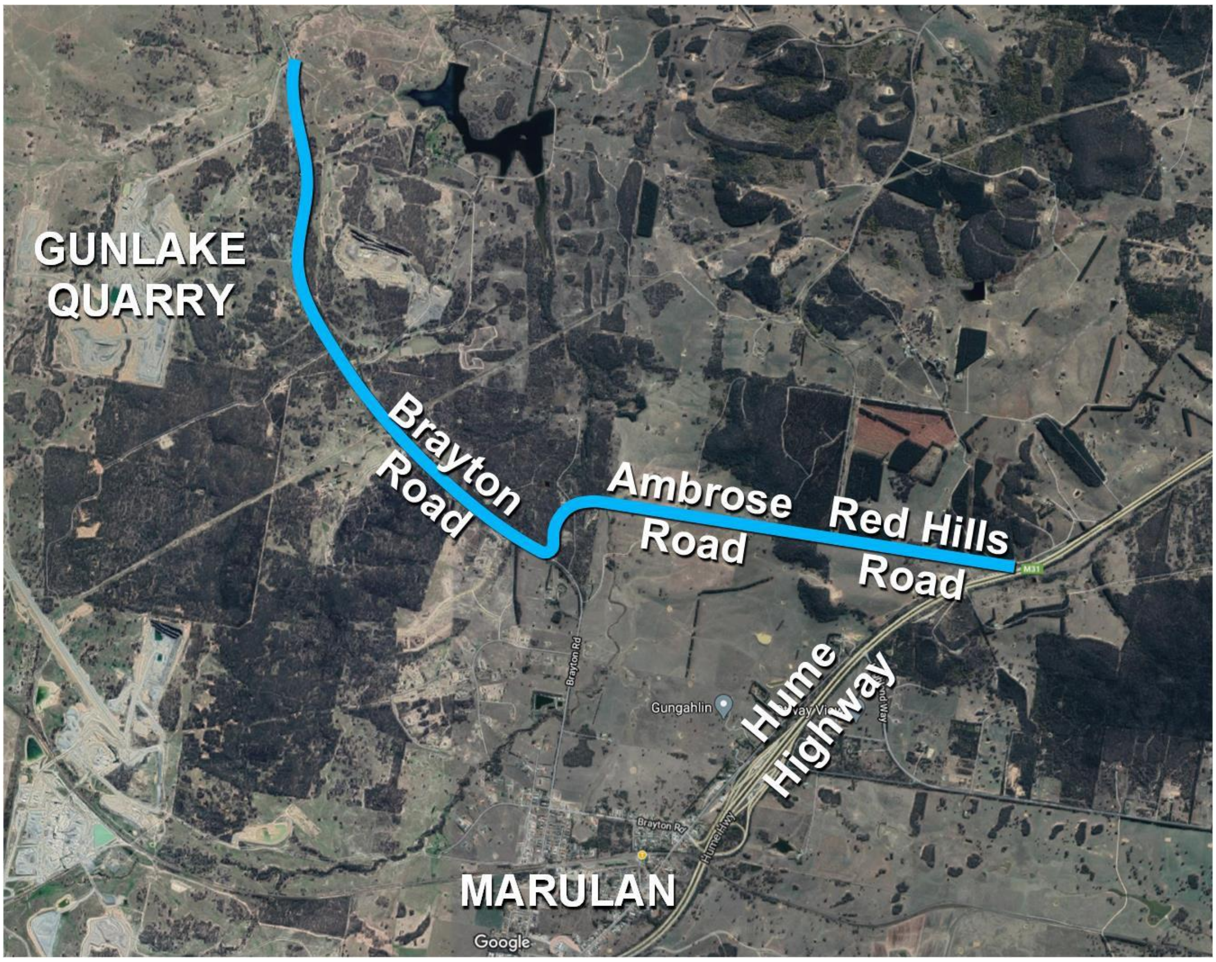
Gunlake have worked with Council over recent years to upgrade and maintain the primary transport route to a standard that mitigates the safety risks and traffic impact of haul truck traffic moving between the quarry and their markets.

The purpose of this road safety audit of the existing road is to identify the crash risk potential to users of theroute. Where a crash risk has been identified by the audit team, practical suggested actions to mitigate thatrisk have been suggested for consideration.

1.2 SITE DESCRIPTION

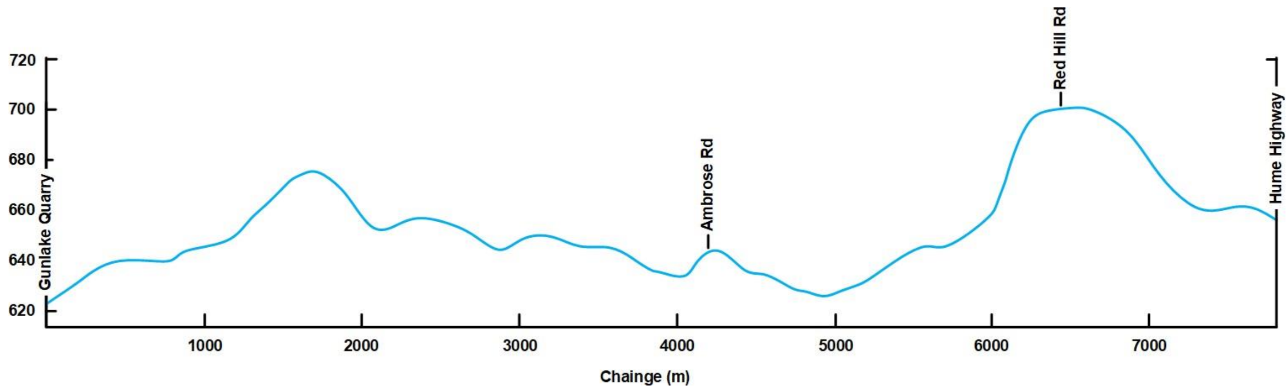
Brayton Road, Ambrose Road, and Red Hill Road form the primary transport route between the GunlakeQuarry at Marulan and the Hume Highway; this is a length of just under 8 km. Figure 1-1 indicates theaudited route; Figure 1-2 shows the change in elevation along the length of the audited route.

Figure 1-1: Location of road safety audit



Source: Nearmap (2019)

Figure 1-2: Primary transport route elevation profile



Source: GoogleMaps (2019)

1.3 SCOPE

The road safety audit covers the primary transport route, which includes Brayton – Ambrose – Red Hill Roadfrom the Quarry entrance road to the Hume Highway, a length of just under 8 km.

2 Road Safety Audit Method

The road safety audit of the primary transport route has been conducted by applying the principles and approach of the Austroads Guide to Road Safety: Part 6A Implementing Road Safety Audit (Austroads2019), and with reference to the Roads and Traffic Authority of New South Wales Guidelines for Road Safety Audit Practices (2011).

A site visit was conducted on Tuesday 13 July 2021. This visit consisted of an audit project inception meeting between Gunlake Quarry representatives and the audit team, followed by the audit team driving thelength of the audit route during both day-time and night-time hours to make observations. Photographs of the route and potential road safety hazards were taken as a record for the audit and for later reference in compiling this report.

The weather during the site visit was partly cloudy and dry.

The road safety audit team is comprised of the following team members:

- David McTiernan (Audit Team Leader)
- Noha Elazar (Audit Team Member – Level 2)
- Michael Timms (Audit Team Member)
- Sonia Roberts (Audit Team Member).

The road safety audit findings and any associated corrective actions identified by the audit team are presented in table format in the Section 3 of this report. Space is provided in the table to document theresponse and proposed action to each of the issues listed.

A level of risk has been assigned for each road safety issue based on the experience of the audit team and with reference to the risk matrix contained in Austroads 2019 and replicated in Table 2-1. An indicative level of residual risk is also indicated to assist understanding the potential effect of adopting the suggested corrective action. The suggested corrective actions have been identified with consideration of thetreatment approach table also contained in the Austroads 2019, also replicated in this report as Table 2-2.

Alternate measures to address the identified road safety issues/hazards may be available. Alternate measures should be assessed applying the same risk assessment process as they may alter the level of residual risk indicated by the audit team.

Table 2-1: Risk level

	FREQUENT	PROBABLE	OCCASIONAL	IMPROBABLE
Catastrophic	Intolerable	Intolerable	Intolerable	High
Serious	Intolerable	Intolerable	High	Medium
Minor	Intolerable	High	Medium	Low
Limited	High	Medium	Low	Low

Table 2-2: Treatment approach

RISK	SUGGESTED TREATMENT APPROACH
Intolerable	Must be corrected.
High	Should be corrected or the risk significantly reduces, even if the treatment cost is high.
Medium	Should be corrected or the risk significantly reduced, if the treatment cost is moderate, but not high.
Low	Should be corrected or the risk reduced, if the treatment cost is low.

Source: Austroads 2009

3 Road Safety Audit Findings

The findings of the road safety audit are outlined in Table 3-1. Images of relevant findings and additional information is given in Appendix A.

Table 3-1: Audit findings and suggested corrective actions

NO.	FINDING	EXISTING RISK	SUGGESTED CORRECTIVE ACTION	RESIDUAL RISK	CLIENT REPONSE AND PROPOSED ACTION
GENERAL FINDINGS APPLICABLE ALONG THE LENGTH OF THE AUDIT ROUTE					
1	Delineation – guideposts, linemarking, signage, and supplementary markers Linemarking and guideposts along the route are generally in a good condition, however gaps due to a degradation in condition were noted that lead to inconsistency guiding drivers along the route, sometimes at semi-critical locations such as barrier terminals and on curves,especially in night-time and poor visibility conditions such as fog. Poorly maintained delineation can cause inconsistency in guidance resulting in driver incorrectly interpreting or adapting to changing road conditions and alignment, leading to loss of control and run-off road type crashes.	High	Implement increased surveillance of the route and provide more timely maintenance of guideposts, linemarking, and hazard marker signs (on barrier terminals), including cleaning, repair, and replacement as necessary to ensuredrivers are provided the appropriate level of guidance along the route.	Low	**Notify Council of this risk and suggest it is included in the road inspection and maintenance program.**
2	The speed limit of 100 km/h is considered too high for the type of road and roadside environment present.	High	Reduce the speed limit from 100 km/h to a lower limit better aligned with the principles of the Safe System approach while maintaining appropriate level of service to local communities.	Low	**Council and Gunlake to continue to lobby Transport for NSW to reduce the speed limit.**
GUNLAKE QUARRY ENTRY – BRAYTON ROAD					
3	There is no advanced intersection warning sign on either approach to the Quarry entry intersection. Approaching drivers may not appreciate the potential for merging or slowing and turning traffic, leading to right-angle and side swipe type crashes. It is noted that existing signage warns of changes in lane configuration, approaching, and turning traffic, however this is not adequate to warn of the Quarry access intersection.	Medium	Replace approaching and turning traffic signs with W2-4 'side road intersection' supplemented with W5-22 'trucks entering' signs on both approaches.	Low	**Notify Council of this risk and suggest it is included in the road inspection and maintenance program.**
4	Redundant BB (adjacent double unbroken lines) centreline marking along Brayton Road remains visible potentially creating confusion for drivers about lane discipline. Similarly for the closed left turn slip, left turn arrows remain visible adding to visual clutter of the intersection markings.	Low	Obscure the redundant linemarking and remark valid lines for the wholeintersection to reinforce correct lane arrangements	Low	**Notify Council of this risk and suggest it is included in the road inspection and maintenance program.**
5	The effectiveness of the intersection surface markings is adversely impacted by the build-up of dirt/dust tracking from trucks exiting the quarry. The build-up of dust may also reduce surface friction, potentially impacting vehicletraction and braking distances.	Low	Ensure the intersection is maintained on a regular basis to remove the build-up of dirt and dust on the road surface and therefore improve the prominence of the linemarking.	Low	**Notify Council of this risk and suggest it is included in the road inspection and maintenance program.** **Gunlake will add this to one of the quarry checklists for a more frequent inspection.**
BRAYTON ROAD					
6	Significant sections of Brayton Road have remnant vegetation present along the roadside verges. While no large trees are located in areas representing a high or unacceptable risk, there is a potential for serious crash outcomes in the event of a loss of control type crash at high speed.	Medium	A. Ensure all linemarking and guidepost delineation is maintained in good condition, so drivers are clearly guided about the road alignment and the edge of carriageway. B. Monitor the growth of roadside vegetation and remove new impact hazardsthat develop over time. C. Reduce the speed limit along Brayton Road.	Low	**Notify Council of this risk and suggest it is included in the road inspection and maintenance program.** **Council and Gunlake to continue to lobby Transport for NSW to reduce the speed limit.**
7	The left side guidepost delineation (red) for southbound traffic has poor reflectivity at night, potentially due to a build-up of dirt and dust, leading to drivers not being adequately guided about the edge of the carriageway alignment.	High	Clean, repair, or replace guidepost reflector delineators to ensure good left edge delineation.	Low	**Notify Council of this risk and suggest it is included in the road inspection and maintenance program.**
8	There is no advanced intersection warning sign on either approach to the intersection with Ambrose Road and there is limited delineation of the traffic islands. Approaching drivers may not appreciate the potential for merging or slowing and turning traffic, and at high speed this increases the risk of serious right-angle and side swipe type crashes.	High	Provide W2-4 side road intersection signs on both approaches, paint the median islands with retroreflective white paint and renew the linemarking approaching the intersection.	Low	**Notify Council of this risk and suggest it is included in the road inspection and maintenance program.**

NO.	FINDING	EXISTING RISK	SUGGESTED CORRECTIVE ACTION	RESIDUAL RISK	CLIENT REPONSE AND PROPOSED ACTION
AMBROSE ROAD					
9	The sweeping curve from almost the commencement of Ambrose Road (from the intersection with Brayton Road) is poorly delineated. The curve warning/advisory speed sign is positioned mid-way along the curve and poorly positioned close to another warning sign. In a high-speed environment this risks off carriageway to left on right curve type crashes.	High	A. Relocate the curve warning/advisory (65 km/h) sign nearer the start of thecurve. B. Install chevron alignment markers (D4-6) around the curve to improve guidance to drivers. C. Reduce the speed limit along Ambrose Road.	Medium	**Notify Council of this risk and suggest it is included in the road inspection and maintenance program.** **Council and Gunlake to continue to lobby Transport for NSW to reduce the speed limit.**
10	Light vehicle drivers seeking to turn from Ambrose Road into Brayton Road have limited sight distance into Brayton Road due to the horizontal and vertical alignment of each Brayton Road leg. Noting the road approaches are high-speed (100 km/h), there is the potential for severe right-angle and turning type crashes.	High	A. Replace the current GIVE WAY yield arrangement with STOP. B. Provide W2-4 side road intersection signs on both approaches in Brayton Road, paint the median islands with retroreflective white paint and renew the linemarking approaching the intersection. C. Reduce the speed limit along Brayton Road.	Low	**Notify Council of this risk and suggest it is included in the road inspection and maintenance program.** **Council and Gunlake to continue to lobby Transport for NSW to reduce the speed limit.**
11	Lines of sight for light vehicle drivers waiting to turn out of Red Hill Road (side roadleg) are restricted to sub-optimal distances. The line of sight into Ambrose Road to the right is partially impeded by the guardrail; the lineof sight into Red Hill Road (left) is impeded by the new growth of sapling trees. The restricted lines of sight may lead drivers to misjudge approaching traffic, particularly during poor weather (rain and fog) conditions, leading to potential right angle, rear-end and side swipe type crashes at high speed.	High	A. Reduce the speed limit along Ambrose and Red Hill Road. B. Relocate the existing guardrail to improve the line of sight. C. Trim/remove the vegetation and monitor to ensure adequate line of sight is maintained. D. Consider alternate measures to warn/inform motorists of the hazard to improve safety, particularly during adverse weather conditions.	Low	**Notify Council of this risk and suggest it is included in the road inspection and maintenance program.** **Council and Gunlake to continue to lobby Transport for NSW to reduce the speed limit.**
12	There is a build-up of loose gravel material in the intersection (Red Hill Road - north-south running side road leg) risking vehicles losing traction approaching the STOP line.	High	Remove loose gravel and monitor to ensure further build up is removed.	Low	**Notify Council of this risk and suggest it is included in the road inspection and maintenance program.**
13	The sequencing of signs approaching the Hume Highway intersection is potentially confusing to drivers with multiple messages and instruction about the road ahead being conveyed over a relatively short distance. This could lead to drivers missing key information to prepare for the changing roadahead. REDUCE SPEED – Left curve warning/65 km/h advisory – Concealed Dwys – Right curve warning/25 km/h advisory – Tilt truck (left bend). The right bend/25/km/h (W1-1) sign is potentially misleading given the close proximity of the left bend required to enter the Hume Highway, and it conflicts withthe tilt truck sign.	Low	Each sign is considered important and provides valid information about the road ahead. Replacing the W1-1 right bend sign with a W1-2 reverse bend (right then left) signwill assist driver understanding of the road ahead.	Low	**Notify Council of this risk and suggest it is included in the road inspection and maintenance program.**
14	Heavy vehicles appear to be pulling up in front of the Pines Lodge property entrances. The line of sight to this location is restricted by the road geometry and embankments and the area is less than ideal for stopping.	Medium	Renew the edgeline marking and consider NO STOPPING signs to reduce thepotential for vehicles to stop in this area.	Low	**Notify Council of this risk and suggest it is included in the road inspection and maintenance program.**
15	It appears that heavy vehicles turning off the Hume Highway into Red Hill Road are turning wide, possibly to maintain speed, and as a result are crossing the BB centreline before proceeding on in their lane. This risks a collision with oncoming traffic. It was also observed that residents turning off the Hume Highway are then turning into private property driveways. Heavy vehicles following may not expect this and if travelling at speed there is the potential for a serious rear-end collision.	Medium	Improved turn discipline and reduced turn speed is required. Replace the BB centreline with a painted island extending from the end of the concrete splitter island to merge with the BB centreline an appropriate distance along Red Hill Road. This will reinforce and make visually clear the separation of the opposing traffic lanes. Note: a break in the lines will be required to permit residents to turn into the private property entries at this location.	Low	**Notify Council of this risk and suggest it is included in the road inspection and maintenance program.**

4 Concluding Statement

The road safety audit of Brayton Road – Ambrose Road – Red Hill Road, Marulan (the primary transport route)has been conducted in accordance with Austroads Guide to Road Safety: Part 6A Implementing Road Safety Audits.

The audit has been conducted with the purpose of identifying issues which present a potential safety hazardfor general public use of the road, and as such the suggested actions are for the consideration and response by the road manager.

The identified road safety issues are presented in Table 3-1 of this report along with an indicative level of riskfor pre and post-treatment scenarios. No guarantee is given that every safety deficiency has been identified by this audit.

The road safety audit team believe that adoption of the suggested actions will improve the level of safety, butthis does not guarantee absolute safety for all road users.

Audit Team

David McTiernan	Noha Elazar	Sonia Roberts	Mick Timms
Audit Team Leader (L3)	Audit Team Member (L2)	Audit Team Member	Audit Team Member

Appendix A Audit Images Illustrating Audit Findings

ISSUE NO.		
1	 Ambrose Road (looking west)  Brayton Road (looking south)	 Red Rill Road (looking west)

ACCREDITED

ISSUE NO.		
3	 Brayton Road (north of Quarry Access looking south)	
4,5	 Quarry Access	 Brayton Road (Quarry Access looking south)

iRAP ACCREDITED

ISSUE NO.	
6,7	 Brayon Road (looking south)  Ambrose Road (looking east)
8	 Brayton Road (looking south to Ambroase Road)

ISSUE NO.		
9	 Ambrose Road (looking east)	
10	 Ambrose Road (looking norht into Brayton Road)	 Ambrose Road (looking south into Brayton Road)

ISSUE NO.		
11 and 12	 Red Hill Road (looking east to Red Hill Road)	 Red Hill Road (looking west to Ambrose Road)
13	 Red Hill Road (looking east)	 Red Hill Road (looking east)

ISSUE NO.	
13	
14	 Red Hill Road (looking east)

ISSUE NO.

15


Red Hill Road (looking west)


Red Hill Road (looking west)

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