



Gunnedah second road over rail bridge

Recommended Option Report

AUGUST 2014

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Executive summary

Background

Roads and Maritime Services (Roads and Maritime) is carrying out the development and assessment of options for the Gunnedah second road over rail bridge project.

The Abbott Street Bridge on the Oxley Highway is a Higher Mass Limit (HML) deficient bridge, restricting the transport network through Gunnedah. The provision of a second road over rail bridge in Gunnedah will facilitate a HML route through Gunnedah, delivering an additional continuous 660 kilometres for HML freight vehicles.

The objectives of this project are to:

- Provide a grade separated crossing of the rail line to facilitate a HML route through Gunnedah
- Improve local traffic efficiency
- Improve road safety
- Improve road transport productivity, efficiency and reliability of travel
- Minimise the impact on the natural, cultural and built environment
- Provide value for money.

The project also responds to the Transport for New South Wales and Australian Rail Track Corporation (ARTC) level crossing closure policies by removing a vehicular and pedestrian crossing at New Street.

In May 2013, Roads and Maritime sought community feedback on three preliminary options for the project. These options were described in the May 2013 community update and the *Preliminary Concept Options Report* (Roads and Maritime, May 2013).

Further investigations

Following consideration of community and stakeholder feedback on the preliminary options display, each option was further developed and assessed against the project objectives. During this process, it was identified that while Option C performed strongest against constructability and visual impact criteria, it did not perform well against community, engineering and environmental assessment criteria.

Further investigations also identified that Option A presented significant constructability challenges and required very steep grades to maintain the required clearances over the railway line.

As a result, a refined Option C was developed which included elements of Options B and C which would better achieve the project objectives. Options A, B and the refined Option C were then assessed at a Value Management Workshop held in September 2013. The Value Management

Workshop was independently facilitated and included representatives of the project team, ARTC, Transport for NSW and Gunnedah Shire Council. While not a decision making body, the value management workshop recommended that a refined Option C be adopted as the preferred route.

New Street level crossing

In March 2014, Roads and Maritime confirmed with Transport for NSW Freight Branch and ARTC, that the project will replace the existing level crossing at New Street. The crossing will be closed to vehicular traffic, pedestrians and cyclists when the new bridge is open to traffic.

The key advantages of closing a level crossing relate to safety for motorists and pedestrians and improved transport efficiency. The disadvantage of closing the level crossing was a potential business impact on Barber Street businesses due to the removal of direct access for motorists, pedestrians and cyclists.

Barber Street connectivity

In response to feedback from some sections of the local business community, Gunnedah Shire Council, the local community and representations from the Local Member about the New Street level crossing closure, an economic impact assessment was undertaken. The report identified there would be an economic impact in Barber Street, with business being redistributed within the Gunnedah Central Business District.

Providing a direct connection from the project to Barber Street would help manage this business impact. There are however, several disadvantages in providing a direct connection to Barber Street. These include additional project costs, and the acquisition of two properties to provide sufficient area for the intersection to be constructed.

Recommended option

Feedback provided by the community combined with technical, environmental and social investigations and the outcomes of the Value Management Workshop were carefully considered in identifying the recommended option.

The recommended option is the refined Option C (figure S1). It would be built over the rail line, west of the Gunnedah Maize Mill to connect the Oxley Highway roundabout with a new roundabout at the Conadilly and Warrabungle streets intersection. It would also maintain direct access into Barber Street.

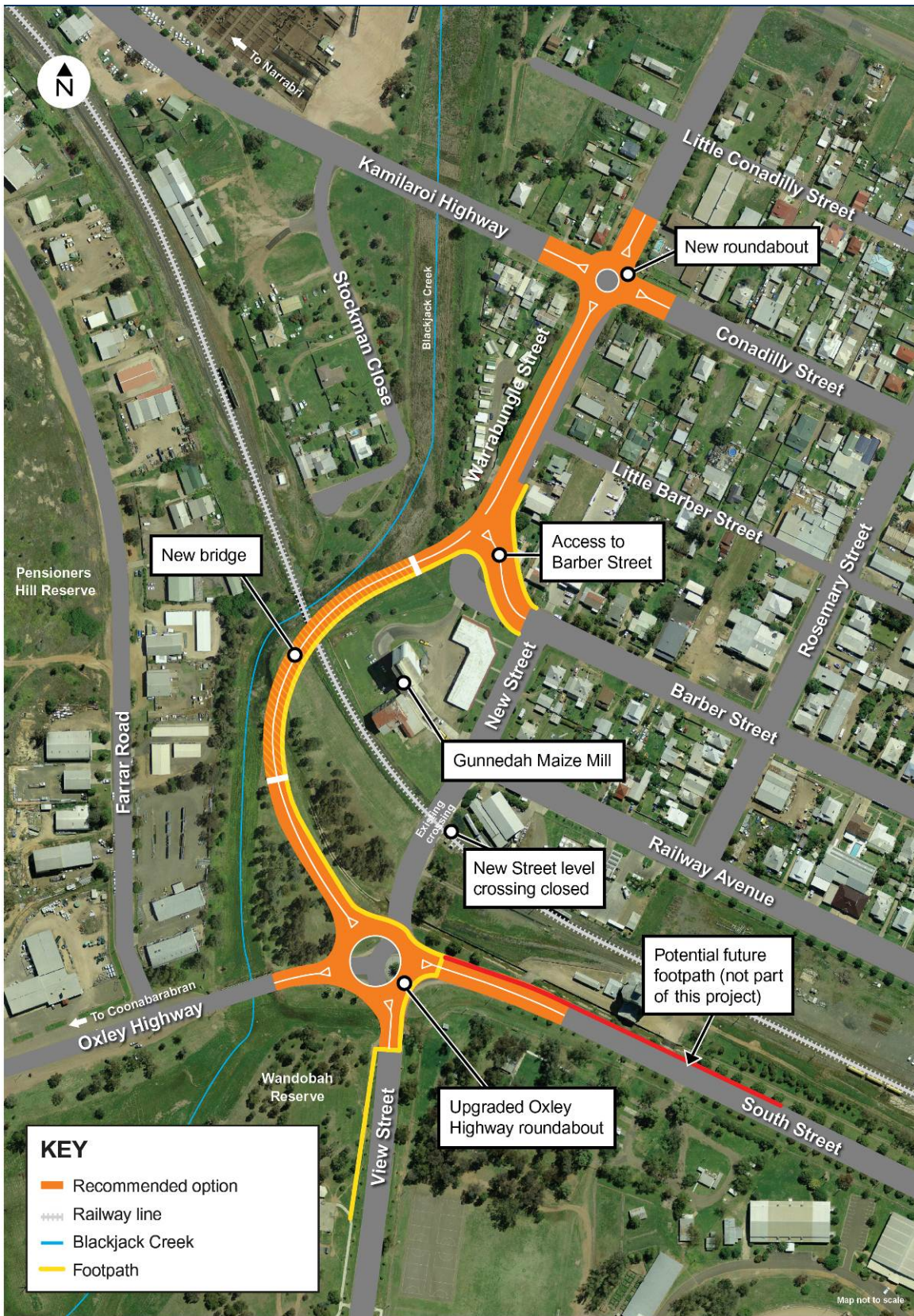


Figure S1: Recommended Option C (Refined)

The recommended option considers the environment, community and other constraints of the study area including:

- Reduces the project footprint and minimises environmental effects near the Oxley Highway
- Avoids core Koala habitat in the Wandobah reserve
- Minimises Blackjack Creek flooding effects
- Is easier to build, has an improved curve and allows appropriate railway clearance for the future duplicated rail line
- Minimises the business impact to the Barber Street precinct
- Improves efficiency by minimising impact to existing infrastructure, including the Oxley Highway roundabout, View Street connection and culvert across Blackjack Creek.

The recommended option will be placed on public display for feedback between 15 August to 12 September 2014. Community drop-in sessions will be held over this period at the locations and times identified in the community update. Representatives of the project team will be available at these sessions to discuss the recommended option in more detail, and respond to questions that the community may have.

Next steps

Community feedback on the recommended option will be considered prior to a final decision being made later this year. An environmental assessment and concept design will then be prepared on the preferred option.

The concept design and environmental assessment will be displayed for community comment.

Glossary of terms

AADT	Annual average daily traffic
ABS	Australian Bureau of Statistics
AHD	Australian Height Datum, a common national plane of level approximately equivalent to the height above sea level
AHIMS	Aboriginal Heritage Information Management System
Alignment	Design term referring to the spatial position of a proposed road both horizontally and vertically.
AM peak	Morning traffic peak period, that is, from 7 am to 9 am
ARI	Average recurrence interval, the average or expected value of the periods between exceeding a given rainfall total accumulated over a given duration
ARNDT	A software program whose purpose is to enable road designers to identify potentially hazardous geometry of roundabouts
ARTC	Australian Rail Track Corporation
Austrroads	Austrroads is the association of Australian and New Zealand road transport and traffic authorities
BCR	Benefit-cost ratio
BOM	Bureau of Meteorology
CBD	Central business district
CIRCLY	CIRCLY is a pavement design software program for roads and highways
CMA	Catchment Management Authority
Darzin	A software database used for managing stakeholder and community liaison
DDA	The Australian Government's Disability Discrimination Act 1992
Double stacking	ARTC clearance requirement of 7.10m between the top of rail and the bridge soffit, allowing for two containers stacked on a rail car.
DP&I	NSW Department of Planning and Infrastructure
DSEWPaC	Federal Department of Sustainability, Environment, Water, Population and Communities
EEC	Endangered ecological community
EIS	Environmental Impact Statement
EPA Act	Environmental Planning and Assessment Act 1979
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPL	Environmental Protection Licenses
HEC-RAS	A software program that models the hydraulics of water flow through rivers and other channels

HML	Higher Mass Limits, a nationally agreed scheme that permits approved heavy vehicles to operate with additional mass on certain types of axle groups, on a restricted road network and subject to specified conditions
HPAA	High Pedestrian Activity Area
kmh	Kilometres per hour
LALC	Local Aboriginal Land Council
LEP	Local environmental plan
LGA	Local government area
Monte Carlo	Monte Carlo simulation is a computerized risk quantitative analysis used to derive outcomes for decision making, particularly for assigning contingency.
MCA	Multi Criteria Assessment
MNES	Matter of National Environmental Significance
mtpa	Million tonnes per annum
NPV	Net Present Value
OEH	The Office of Environment and Heritage
PEP	Protection of the Environment Policies
PM Peak	Afternoon traffic peak period, that is, from 3 pm to 5 pm
POEO	Protection of the Environment Operations
REF	Review of Environmental Factors
Roads and Maritime	NSW Roads and Maritime Services
Route	General term referring to the corridor in which an option is located
RVC	Regional Vegetation Communities
RNP	Road Noise Policy
SEPP	State Environmental Planning Policy
Sidra Intersection	Sidra Intersection is a traffic evaluation software program used for road intersection performance and network capacity analysis
Single stacking	ARTC clearance requirement of 5.15m between the top of rail and the bridge soffit, allowing for one container stacked on a rail car.
SIS	Species Impact Statement
SEWPAC	Department of Sustainability, Environment, Water, Population and Communities
SoundPLAN	A software program that models noise impacts
TfNSW	Transport for New South Wales

1 Introduction

1.1 Project background

Roads and Maritime Services (Roads and Maritime) is carrying out the development and assessment of the options for the Gunnedah second road over rail bridge project.

Gunnedah is situated in northern NSW, 80 kilometres west of Tamworth. The town is bisected by the Hunter Valley Rail Corridor, which separates the town centre and business district in the north from the growing residential areas in the south. The Dr P.H Stanley Bridge on Abbott Street (Oxley Highway), known locally and referred to here as the Abbott Street Bridge, is currently the only grade separated crossing of the railway line in Gunnedah.

The Abbott Street Bridge was constructed in 1941 and is restricted for use by Higher Mass Limit (HML) freight vehicles, constraining the transport network through Gunnedah. Bloomfield Street and Boundary Road are currently used as an oversized heavy vehicle route for vehicles travelling through Gunnedah. When coal trains pass through town the through and local traffic is delayed at the New Street level crossing. Gunnedah Shire Council has sought to solve this problem for many years, including representations to the NSW Government.

The provision of a second road over rail bridge in Gunnedah will facilitate a HML route that delivers an additional continuous 660 kilometres for HML freight vehicles.

With major coal development in the Gunnedah basin, the length and frequency of coal trains has been increasing, causing extended delays at the nearby level crossings. With delays expected to continue and increase in the future, Roads and Maritime and the Gunnedah Shire Council are committed to identifying a grade separated crossing that will improve local and through traffic efficiency.

The study area in figure 1.1 has been determined to meet the project objectives of Roads and Maritime, the Council and the community.

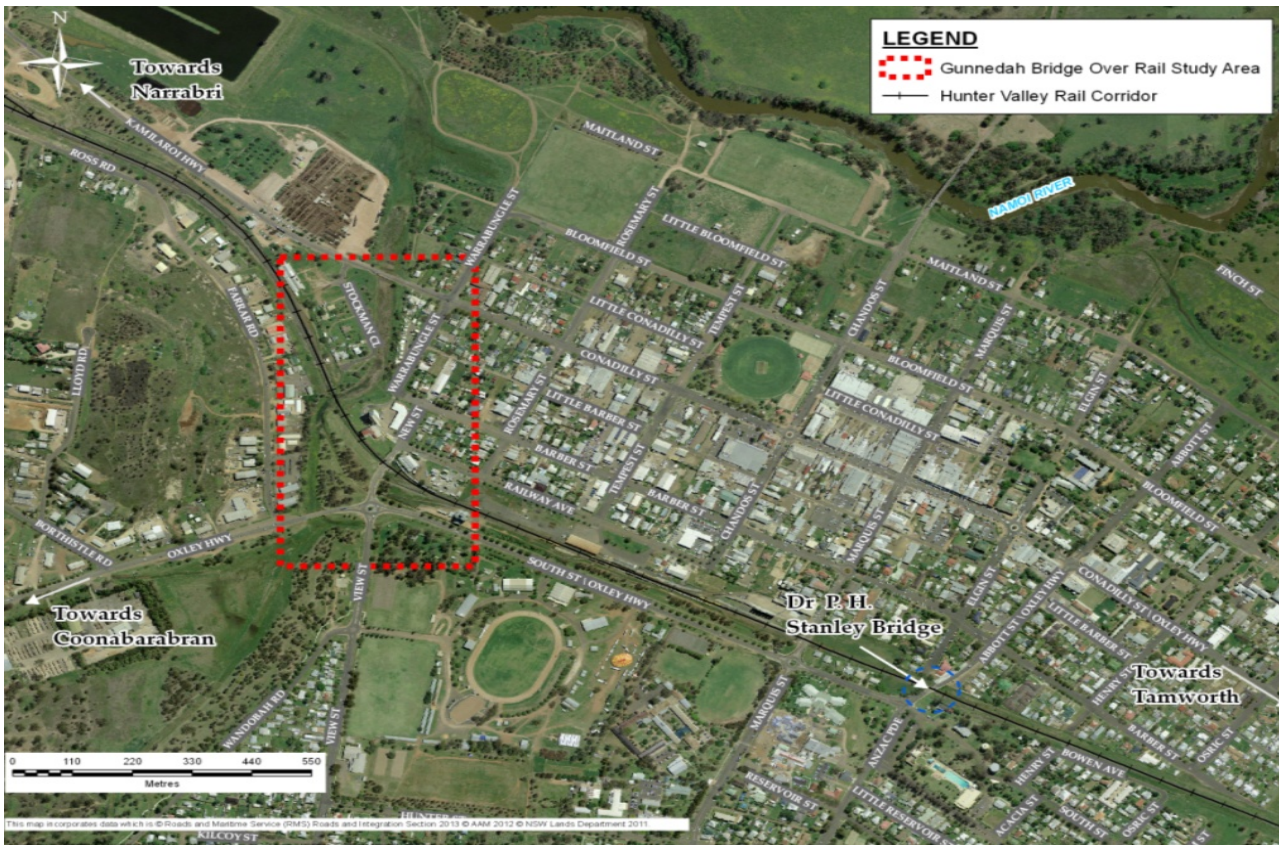


Figure 1.1: Map of study area and surrounding streets in Gunnedah

1.2 Purpose of the report

This report builds on the work documented in the *Preliminary Concept Options Report* (Roads and Maritime, May 2013).

The purpose of this *Recommended Option Report* is to document and summarise the project processes and methodology used to assess the three shortlisted options and identify a recommended option.

This report:

- Summarises work carried out to date
- Describes the design development carried out for the three shortlisted options
- Documents the assessment method and process for identifying a recommended option to be taken forward for further community consultation and value management.
- Documents, where relevant, potential mitigation of impact on the shortlisted options
- Explains the recommended option
- Outlines the next steps for finalising the recommended option for a grade separated crossing of the railway line.

1.3 Assumptions and limitations

This report provides information on the development of the design for the shortlisted preliminary options and the selection process carried out to identify a recommended option.

Detailed specialist investigations have been used to inform the design development and assessment process.

The designs presented in this report have been developed to a strategic concept level for the purposes of carrying out a comparative assessment. The recommended option will be further refined during the concept design phase, based on further investigations.

2 Project strategic context, need and objectives

2.1 Strategic context

The overarching policies and strategic documents relevant to the second road over rail bridge are described in detail as part of the *Preliminary Concept Options Report*. Key documents directly relevant to this project have been listed below:

- *NSW 2021: A Plan to Make NSW Number One* (NSW Government, 2011)
- *NSW Long Term Transport Master Plan* (TfNSW, September 2012)
- *Bridges for the Bush Initiative* (NSW Government 2012)
- *Strategic Land Use Plan – New England North West* (NSW Government 2012)
- *Gunnedah Community Strategic Plan 2012-2022* (Gunnedah Shire Council 2011)
- *Australian Rail Track Corporation (ARTC) 2013-2022 Hunter Valley Corridor Capacity Strategy* (ARTC June 2013).

Bridges for the Bush program

The Bridges for the Bush program is a NSW Government commitment to improve road freight productivity by replacing or upgrading bridges over the next five years at 17 key locations in regional NSW (see figure 2.1).

Bridges for the Bush includes replacing or upgrading five key priority Higher Mass Limit (HML) deficient bridges on State managed roads and 12 timber truss bridges on State, regional and local roads.

The Bridges for the Bush program will enhance freight productivity in country NSW. It is an investment in critical infrastructure to remove a number of significant freight pinch points or bottlenecks on the State road network and to improve the safety and reliability of some old bridge structures. The replacement or upgrade of five HML deficient bridges alone will remove 8000 heavy vehicle trips from the freight task each year.

The provision of the Gunnedah second road over rail bridge will remove the only remaining HML deficient bridge on the Oxley Highway. It will deliver a continuous 660 kilometres for HML freight vehicles.

Bridges for the Bush

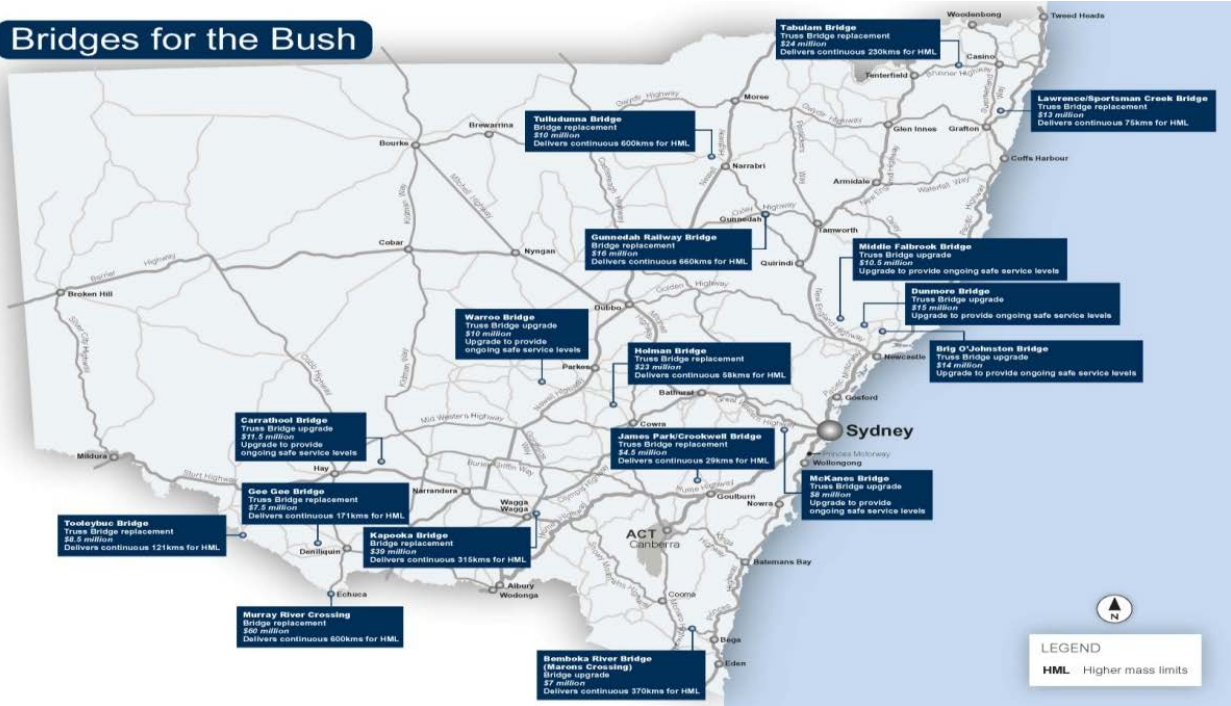


Figure 2.1: Bridges to Bush program

NSW Strategic Land Use Plan – New England North West

Strategic Land Use Plan – New England North West (NSW Government 2012) highlights that a major driver for the project in its current location is the predicted economic growth within the New England north west region. The township of Gunnedah is a connecting point for a number of roads in the region, particularly into the areas which are to be supporting the growing mining industry.

Gunnedah has an important role to play in providing the connecting infrastructure to support this industry and to provide the associated social and housing services. The provision of the Gunnedah second road over rail bridge would support this strategy for the Gunnedah locality.

ARTC 2013-2022 Hunter Valley Corridor Capacity Strategy (June 2013).

ARTC 2013-2022 Hunter Valley Corridor Capacity Strategy (ARTC June 2013) is the latest edition of its annual planned infrastructure enhancement strategies. ARTC has been releasing annual strategy updates, setting out how it plans to ensure that rail corridor capacity in the Hunter Valley stays ahead of coal demand.

In the above edition, export coal volumes are predicted to rise from 158 million tonnes per annum in 2013 to 204 million tonnes per annum in 2018.

The provision of the second Gunnedah road over rail bridge seeks to assist ARTC in addressing these impacts.

2.2 The need for a grade separated crossing

The Abbott Street Bridge is currently the only grade separated crossing of the railway line in Gunnedah, and is restricted for use by HML freight vehicles.

Bloomfield Street and Boundary Road are currently used as a heavy vehicle bypass for heavy vehicles travelling on the Oxley Highway and Kamilaroi Highway through Gunnedah. The New Street level crossing also carries local traffic between Gunnedah's CBD to the north of the railway and the residential areas south of the line. All oversized heavy vehicles (excluding HML freight vehicles) currently using the local road network are individually permitted by Gunnedah Shire Council.

The increased length and frequency of freight trains due to major coal developments in the Gunnedah Basin, has led to frequent extended closures of the New Street level crossing for train passage, causing significant delays for motorists and pedestrians. With delays expected to continue to increase in the future, there is a need to improve local and through traffic efficiency by providing a second grade separated crossing of the rail line.

Figure 2.2 summarises the existing road and rail system in Gunnedah.



Figure 2.2: Existing road and rail system in Gunnedah

2.3 Project purpose and objectives

Project purpose

The purpose of this project is to identify and select a preferred concept option for a second grade separated crossing of the existing railway line in the vicinity of the New Street level crossing.

Project objectives

The key objectives have been established by Roads and Maritime in collaboration with key stakeholders for this project. They are:

- Provide a grade separated HML route through Gunnedah
- Improve local traffic efficiency
- Improve road safety
- Improve road transport productivity, efficiency and reliability of travel
- Minimise the impact on the natural, cultural and built environment
- Provide value for money.

Supporting objectives

To assist in achieving these project objectives, the following supporting objectives have been developed:

- Provide a grade separated HML route through Gunnedah
 - Provide a compliant engineering design
 - Provide a grade separation with minimum complexity in construction, including site access and staging work
 - Provide a design which requires minimum ongoing operation/maintenance works and minimises the work health and safety (WHS) risk for maintenance personnel
 - Provide HML route through Gunnedah by agreement with Gunnedah Shire Council.
- Improve local traffic efficiency/ transport productivity and reliability
 - Increase network capacity
 - Improve traffic flow
 - Reduce traffic durations/delay.
- Improve road safety
 - Minimise vehicle conflict points

- Provide suitable and safe pedestrian and cycle routes
- Increase HML vehicle access by 660 kilometres.
- Minimise the impact on the natural, cultural and built environment
 - Minimise visual impact
 - Minimise ecological impact
 - Minimise impact on heritage
 - Minimise noise and air quality impact
 - Minimise impact on drainage/water quality/flooding
 - Minimise impact on property
 - Minimise impact on social environment.
- Provide value for money
 - Provide a design that is affordable and within the budget for the project
 - Provide a justifiable benefit/cost ratio for the life of the structure.

3 Preliminary options

Preliminary technical and environmental investigations were carried out to identify the likely constraints and opportunities within the study area. These included:

- The Gunnedah Maize Mill (also known as Meggitts Flour Mill) is located in the middle of the study area
- Blackjack Creek is an identified floodplain that becomes inundated during large storms and backwater flooding from the Namoi River
- Vegetation mapped as NSW listed endangered ecological community, White Box, Yellow Box, Blakely's red gum woodland, as well as potential koala migration corridors are located in the middle of the study area
- Pedestrian and cyclist connectivity between residential areas south of the railway line and the business district north of the railway line
- ARTC vertical and horizontal clearance requirements for single and double stacking
- The visual and spatial relationship between Pensioner's Hill, the floodplain and built vertical elements are features that characterise the town.

An initial review of the 19 options removed several that either did not meet the minimum design requirements or the objectives of the project.

Nine options were retained for assessment at the internal technical workshop held in February 2013. This workshop was attended by the project team, Roads and Maritime and Gunnedah Shire Council.

The assessment of these options considered the project objectives and the key constraints of the study area identified above. The workshop then shortlisted three options for further investigation and consultation and are described below and illustrated in figure 3.1.

Option A: A new bridge in place of the New Street level crossing. The bridge would span from just south of Barber Street to the Oxley Highway roundabout, which would be raised.

Option B: A new bridge west of the Mill to connect the Oxley Highway roundabout with Warrabungle Street, north of the Barber Street intersection. The bridge alignment would run close to the railway on its south side. The New Street level crossing would be closed with this option.

Option C: A new bridge west of the Mill to connect the Oxley Highway roundabout with Warrabungle Street. The bridge alignment would start on View Street and make a wide arc west of the Mill. A new roundabout would be constructed on the Oxley highway and the existing roundabout removed.



Figure 3.1: Preliminary options presented at community drop-in sessions – May 2013

4 Community involvement and feedback

This chapter describes the community involvement and consultation activities to date and community feedback obtained from the drop-in sessions, private meetings and feedback forms completed in May 2013, and feedback from Gunnedah Shire Council.

4.1 Community involvement to date

Community interactions that have taken place since the release of the *Preliminary Concept Options Report* (May 2013) are summarised here.

- Community update published and distributed in May 2013 to all residents of the Gunnedah township and stakeholders summarising the three shortlisted options. Letters and copies of the community update sent to affected property owners
- The *Preliminary Concept Options Report* (Roads and Maritime, 2013) available on the project website and placed on public display in three Gunnedah locations (Gunnedah Shire Council, Gunnedah Shire Library and Gunnedah Motor Registry)
- Advertisements inviting the community to the drop-in sessions were printed in the Namoi Valley Independent and the Northern Daily Leader. Two community information sessions held and members of the project team were available. A total of 58 people attended
- Held meetings with eight affected property owners
- Seventy three feedback forms received during the consultation period
- A *Community Submissions Report* (Roads and Maritime, 2013) was published summarising all feedback received during the consultation. Questions and Answers fact sheet distributed to affected property owners and other stakeholder that provided further project information.

4.2 Community feedback

In May 2013, the Gunnedah community was invited to comment on the three preliminary options. As part of this process, the community was asked, through a feedback form, to rank their bridge option preference. While the selection of the recommended option is not chosen by public referendum, the community's preferences and the issues that underpin preferences were carefully considered.

Preferences

On the feedback form, respondents were asked to rank each preliminary bridge option in order of preference (first, second and third). Of the three options, Option B received the largest number of first preference votes with 28; Option A received 24 votes; and Option C received 11 votes. Note that almost the same number of people selected Option A as their first preference and their third and that Option B had the most number of first preference votes and the least number of third preference votes.

Key topics

The feedback provided were classified by topic (figure 4.1). The top five topics identified were:

- Business/services patronage
- Traffic flow and travel times
- Future of existing New Street level crossing
- Property access
- Project funding and cost.

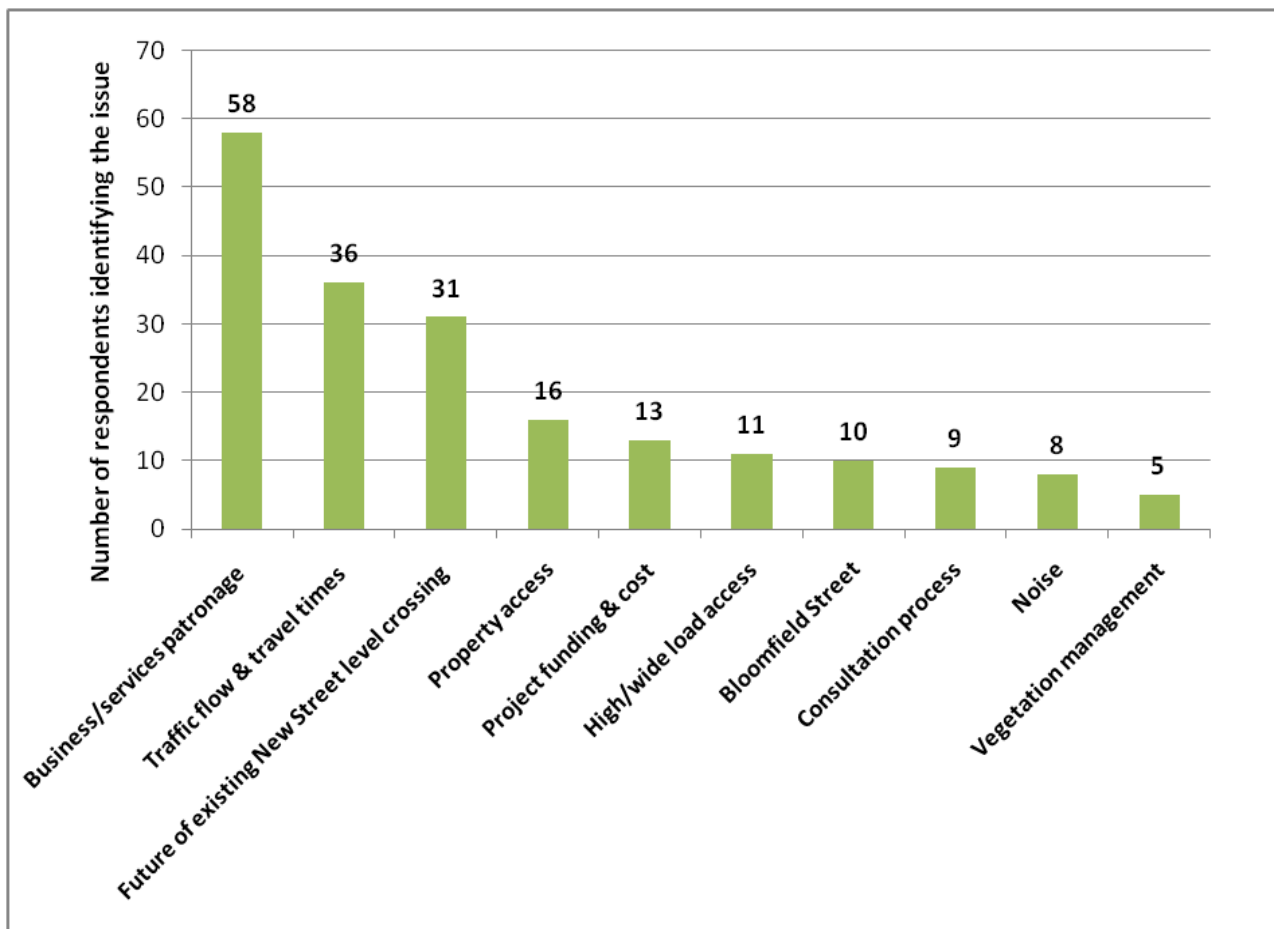


Figure 4.1: Top 10 topics raised in May 2013 community consultation

Table 4.1 summarises the key issues raised by the community that were considered by the project team when determining the recommended option.

Table 4.1: Summary of project responses to key issues raised by the community - May 2013

Key issues	Project response
Negative impact on Bloomfield Street from	Provision of a dedicated HML route is a key objective of this project and will improve traffic flow through Gunnedah.

Key issues	Project response
HML use	<p>The recommended option diverts HML freight vehicles over the new bridge to Warrabungle Street and along Bloomfield Street, the current heavy vehicle route.</p> <p>A new roundabout will be constructed at the Conadilly/Warrabungle Street intersection, improving traffic flow.</p> <p>Roads and Maritime is working with Gunnedah Shire Council to reclassify the heavy vehicle by-pass to provide access for HML freight vehicles. This would provide contributory State funding to assist with the maintenance of this route.</p>
Maintain access to Barber Street via the New Street level crossing	<p>In response to feedback from some sections of the local business community, Gunnedah Shire Council, the local community and representations from the Local Member regarding the potential negative effect on the Barber Street precinct businesses as a result of the closure of the New Street level crossing, an economic impact assessment was undertaken. This revealed there would be an impact in Barber Street, with business being redistributed within the Gunnedah Central Business District. Providing a direct connection from the project to Barber Street would help manage this business impact.</p> <p>The recommended option will enable unimpeded access to Barber Street without the current traffic delays at the New Street level crossing.</p>
Increased dust from new bridge	<p>Environmental management plans will be prepared for the construction phase to address this.</p>
In high risk flooding area	<p>A flood study was completed as part of this <i>Recommended Option Report</i> (see section 5.3). The proposed height and extent of the new bridge minimises the potential impact of flooding.</p>
Impacts on recreational areas	<p>The proposed height and extent of the new bridge minimises the potential impact on any recreation activities in the area.</p>
Negative impact on Blackjack Creek vegetation	<p>The new bridge is a multi-span structure crossing the rail corridor, and open space. Retaining walls on both bridge approaches minimise the environmental footprint. The recommended option incorporates preliminary studies, including a tree survey to limit its impact on the natural environment. The Option C (Refined) alignment was specifically optimised to minimise the impact on trees.</p> <p>An environmental impact assessment will be carried out as part of the next stage of the project.</p>
Provide high/wide load access across the new bridge	<p>The new bridge and roundabouts will accommodate access for high and wide loads.</p>

Key issues	Project response
Acquisition of land	<p>The recommended option will require a minimal acquisition of land from the Warrabungle Street caravan park.</p> <p>A land swap arrangement is proposed with Gunnedah Maize Mill to allow for an optimised crossing of the rail line.</p> <p>The connection from the Option C (Refined) to Barber Street will require the acquisition of two properties to provide sufficient area to construct an intersection.</p>
Increased noise along new route	<p>An initial noise and vibration report was prepared and further investigations will be carried out as the design progresses.</p>
Improved pedestrian safety	<p>The New Street level crossing will be permanently closed as part of the recommended option. This will improve safety for all road users in Gunnedah.</p> <p>Pedestrian and cycle paths will be upgraded as part of the project.</p> <p>Access will also be provided on the new bridge and through the existing Marquis Street roundabout. Further design phases will include road safety audits to determine the detailed locations of pedestrian and cycle paths.</p>
Vehicle headlights affecting homes when crossing the new bridge	<p>Feedback has been noted and will be considered further in the detailed design phase of the project.</p>
Utilise existing roundabout on View Street to save money and less disturbances	<p>Following the value management workshop, the project team developed the design of the roundabout geometry at Oxley Highway to minimise the land take and maximise operational efficiency. The resulting position is close to the existing roundabout.</p>
Consider a roundabout at Conadilly and Warrabungle Street intersections to remove congestion issues	<p>A new roundabout at Conadilly and Warrabungle Streets will be constructed as part of the new bridge project. This will improve traffic flow through Gunnedah.</p>
Increased vibration affecting residents in vicinity of new bridge (Stockman Close)	<p>An initial noise and vibration report was prepared and further investigations will be carried out as the design progresses.</p>

4.3 Next steps

The community are invited to provide their comments on the recommended option at two community drop-in sessions. These comments will be considered in finalising a decision on the preferred option. An environmental assessment and concept design will then be prepared on the preferred option.

5 Design development

Following the identification of three shortlisted options and receipt of community and stakeholder feedback, each option was further developed to ensure that its performance against each of the project objectives could be assessed. This section outlines the design development process that was carried out and the resulting strategic concept designs that were completed as a result of this work.

5.1 Stakeholder requirements

Gunnedah Shire Council

Gunnedah Shire Council is an active stakeholder in the project and the public participation process. Representatives have been integrated within the project team through attending internal workshops and face-to-face meetings which were held to ensure key concerns and requirements have been considered.

In response to community feedback and representations, at its Council Meeting on 19 June 2013, the Gunnedah Shire Council supported the New Street level crossing to remain open or vehicular access be provided to Barber Street as part of the project to ensure ongoing access into the Barber Street precinct, per its resolution below:

That Council indicate to Roads and Maritime and local member

1. That any second overpass in the vicinity of the heritage Mill site must either:
 - a) provide vehicular access / egress to and from Barber Street (the recommended option), or
 - b) ensure that the New Street crossing remains operational.

Australian Rail Track Corporation (ARTC)

ARTC participated during the public involvement process by completing a survey and has been consulted closely and separately throughout the options assessment process. ARTC indicated a preference for Option A as it requires the closure of the existing level crossing at New Street to vehicular traffic.

The ARTC position was confirmed in their correspondence dated 28 May 2013 which stated the following:

Your preliminary options for the proposed road overbridge were tabled at the ARTC Operations Steering Committee (OSC) on 25 March 2013 and met with general support with the following recommendations below:

- i) Preferred Option A location (7.1m min. clearance) and attached;
- ii) Concept design to allow for future track amplification and vertical clearance requirements to ARTC Standards and Guidelines;

- iii) Roads and Maritime agrees to meet costs for single stack clearance of 5.15m with facility to raise the bridge and approaches to double stacking clearances of 7.1m in the future; and
- iv) Closure of the existing level crossing at New Street. Under the Rail Safety Act 2008 Rail and Road Infrastructure Managers have an obligation to manage risks at level crossings. The only means of completely eliminating risk at a level crossing is to close that crossing. Under Section 99B of the Transport Administration Act 1988, the Minister for Transport is required to approve all level crossing closures.

Upon review of the preliminary design and receipt of the OSC endorsement the brief will be sent to the CEO for the Agreement in Principal to your proposal subject to the following;

- i) Execution of a Works Deed and Infrastructure License; and
- ii) Acceptance to any reasonable ARTC requirements in relation to the design.

The ARTC position on the level crossing issue was confirmed and then reviewed at the value management workshop and subsequent developments (sections 7 and 8).

The major design constraints for each option are the clearances required by ARTC to cross the existing railway with sufficient provision to account for future upgrade works undertaken by the ARTC.

The following criteria apply:

- ARTC policy of allowing single and double stacking clearance is discussed in section 5.1 above. Both clearances (5.15 metres and 7.10 metres) are shown on figure 5.1.
- Horizontal clearance of no less than 17 metres is required to allow duplication of the railway through Gunnedah from the existing one track configuration to two tracks with a parallel vehicle access road for maintenance.

Due to ARTC permitting single and double stacking clearance alternatives, single and double clearances were considered for each of the three concept options using the assessment process to determine the recommended option.

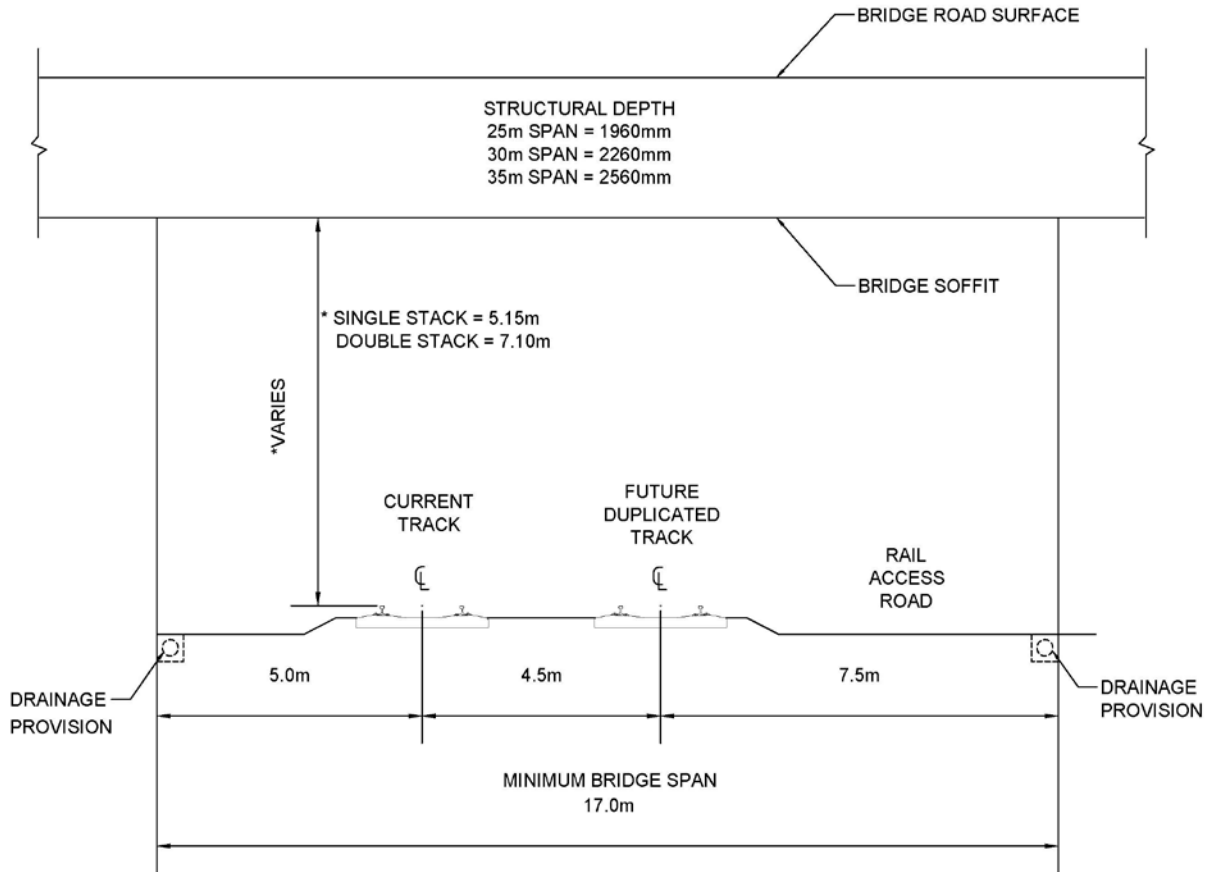


Figure 5.1: ARTC design requirements for single and double stacking clearances

5.2 Alignment optimisation

Following the announcement of the three shortlisted options in May 2013, two community drop-in sessions were held on 22 May 2013. These sessions provided an opportunity for the community to give feedback to the project team on the advantages and disadvantages of each option. This process is described in detail in section 4 of this report.

This feedback, together with the key stakeholder requirements described in section 5.1, helped identify several key issues with the three shortlisted options. These issues included:

- Business and services patronage, particularly on Barber Street
- Traffic flow and travel times
- Potential closure of the existing New Street level crossing
- Property access
- Project funding and cost.

The project team considered these issues when refining the three shortlisted options, focussing on those of most importance to the community and stakeholders.

Table 5.1 summarises the key issues and where these have been addressed in the design development for each option, where applicable. Further details are provided in subsequent sections of this report.

Table 5.1: Summary of key community issues

Key community issue	Action / response to address issue	Reference
Business and services patronage, particularly on Barber Street	Investigate options to provide direct access to Barber Street	Section 5.2
	Investigate alignments to allow New Street level crossing to remain open	Section 5.2
	Ensure access to Mill is retained from both Barber and New Streets	Section 5
Traffic flow and travel times	Carry out traffic modelling to identify future traffic issues and propose intersection upgrades to adequately address these issues.	Section 5.3
	Carry out constructability and staging review to identify ways to limit short term delays	Section 5.4
Future of existing New Street level crossing	Investigate alignments to allow New Street level crossing to remain open	Section 5.2
Property access	Refine alignments to minimise encroachment on private property	Section 5
	Ensure access to Mill is retained from both Barber and New Streets	Section 5

Key community issue	Action / response to address issue	Reference
Project funding and cost	Carry out a first principles, strategic concept, risk-based cost estimate for each option so that full design and construction costs are known	Section 5.4
	Carry out constructability/staging review to ensure each option is practical and more cost effective approaches are identified	

Development of Option C (Refined)

As part of the refinement process, all three shortlisted options were reviewed against the project objectives and the community and stakeholder concerns identified above. Following this review, the displayed Option C was considered to be problematic for the following reasons:

- Significant work would be required to modify the area south of the Oxley Highway due to the View Street realignment. This work would substantially increase the cost for this option for minimal tangible benefit
- It would have negative environmental effects in the vicinity of the Oxley Highway and affecting core koala habitat in Wandobah reserve
- Blackjack Creek flooding would be increased and the drainage channels south of the Oxley Highway affected.

As a result, the project team determined that a refinement of Option C, incorporating the best elements of Options B and C would better achieve the project objectives and successfully address the key issues from the community. Option C (Refined) was developed and became one of the three shortlisted in the previous stage of the project. Table 5.2 outlines the key features of this new alignment. Figure 5.2 outlines the location of the alignments.

Table 5.2: Key features of Option C (Refined) alignment

Option	Key features
Features similar to Option B	Maintains the existing View Street alignment south of the Oxley Highway.
	Proposed roundabout to be close to the same location as existing and upgraded to suit B-double vehicles.
Features similar to Option C	Alignment swings northwest immediately from the proposed roundabout on Oxley Highway to maintain the buffer between the bridge and Mill which was central to the Option C alignment.
New features to Option C (Refined)	A five leg or a four leg roundabout at the Oxley Highway to be compatible with the existing level crossing remaining open or closed.
	Horizontal alignment south of the railway line is a combination of options B and C minimising environmental effects by reducing the project footprint in the vicinity of the Oxley Highway and avoiding core koala habitat in Wandobah reserve.

Option	Key features
	Adoption of 50 km/h design speed allowed for improved alignment optimisation
	Minimises Blackjack Creek flooding effects by reducing construction over Blackjack Creek and the drainage channels south of the Oxley Highway.
	Optimises constructability by improving the curve of the bridge and providing greater railway clearance for the future duplicated railway line
	Improves structural efficiency by retaining existing infrastructure including View Street connection and the culvert across Blackjack Creek.
	Maximises value for money by reducing the overall project cost.

For the purposes of design development, assessment and identification of a recommended option, the refined Option C (Refined) replaces the originally shortlisted Option C from this point forward.

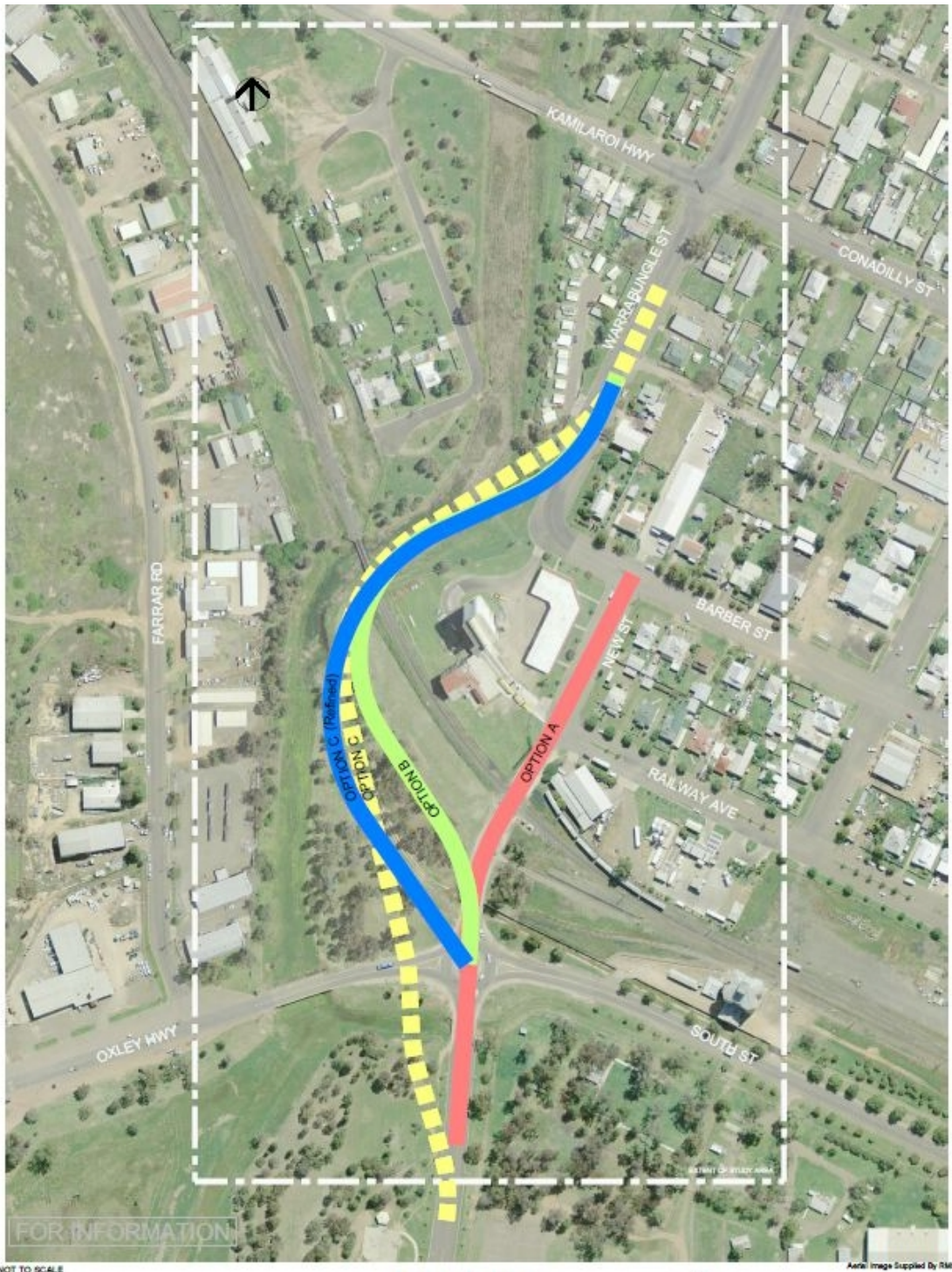


Figure 5.2: Map of options A, B and C (Refined)

New Street level crossing

Following the feedback received and documented in section 4 and the formal position by Gunnedah Shire Council, the project team considered the existing level crossing and access into Barber Street in each option. This section outlines the results of this process.

Option A

The Option A alignment follows New Street alignment and replaces the existing level crossing with a grade separated crossing.

Option B

The Option B alignment runs from the existing Oxley Highway roundabout to the west of the Mill. The key feature of this option is that it runs close to the railway boundary to avoid Blackjack Creek and the existing planted trees as much as possible. However, this feature also creates a high skew angle across the rail line resulting in longer bridge spans and making it more difficult to design and construct.

Minor modifications to the alignment were proposed to try to create a configuration that allowed traffic to continue through the level crossing from the roundabout and from the proposed bridge. However, this area was too constrained to facilitate the required vehicle movements without substantially changing the alignment and compromising its key features.

A compromise solution was suggested to maintain the level crossing for pedestrians and cyclists only, but closing it for vehicles.

Option C (Refined)

The Option C (Refined) alignment runs from the existing Oxley Highway roundabout to the west of the Mill. It provides a wider separation from the Mill property and minimises the impact on the creek and the vegetation. The Oxley Highway roundabout design provides for a four leg or five leg alternatives to provide access to New Street if required

Following the assessment of the three shortlisted options and subsequent value management workshop, additional investigation work was carried out in relation to the impacts associated with the closure of the New Street level crossing. The results of this investigation are outlined in section 9.

Barber Street linkage

Following the community feedback received and documented in section 4 and Gunnedah Shire Council's formal position (section 5.1), the project team has investigated the feasibility to provide access into Barber Street for each option. This section outlines the results of this process.

Option A

Option A runs along New Street and is intended to replace the existing level crossing, tying into the existing intersection with Barber Street. As this is the same as the current alignment, Barber Street links would remain unchanged.

Option B

Option B runs from the existing Oxley Highway roundabout to the west of the Mill. The existing level crossing will be closed to vehicular traffic but may remain open to pedestrians and cyclists (subject to ARTC approval).

Vehicles travelling to Barber Street from Oxley Highway roundabout would therefore need to double back from the Kamilaroi Highway to access the western end of the Barber Street precinct.

Option C (Refined)

Option C (Refined) runs from the existing Oxley Highway roundabout to the west of the Mill. Both a five leg and a four leg roundabout alternatives were developed to keep the level crossing open or closed for vehicles. In the event of the existing rail crossing remaining open, links to Barber Street would remain unchanged.

Note that the following assessment of the three shortlisted options and subsequent value management workshop, additional investigation work was carried out on the economic impact to the Barber Street precinct. The results of this investigation are outlined in section 8.3.

5.3 Investigations

Geotechnical investigations

To support the development of the three concept options, a field geotechnical investigation, laboratory analysis and interpretation of the existing geotechnical conditions was carried out within the study area. The geotechnical investigation was carried out between 22 and 30 July 2013. A total of five machine rotary excavated boreholes were drilled in the locations shown in figure 5.3.

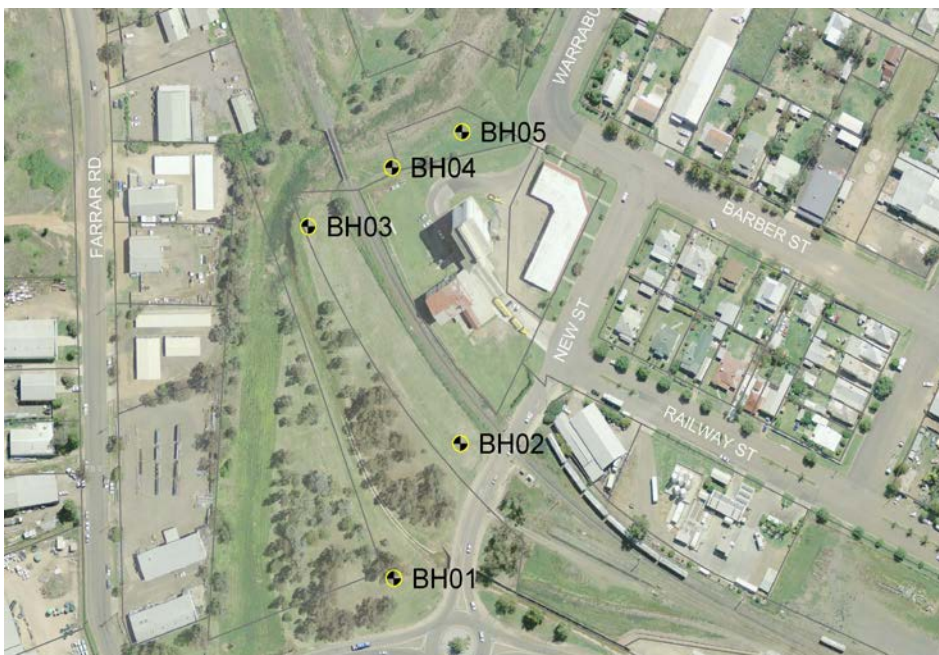


Figure 5.3: Geotechnical borehole locations

A summary of each drilled borehole has been provided in table 5.3 below.

Table 5.3: Borehole (BH) investigation data

Borehole ID	Total Depth Drilled (m)	Rock Coring Depth (m)	Monitoring Well Response Zone (m)
BH01	19.45	Rock not encountered	Not installed
BH02	49.25	Rock not encountered	9.00 – 15.00
BH03	29.10	26.10 – 29.10	Not installed
BH04	35.50	32.50 – 35.50	Not installed
BH05	20.95	Rock not encountered	12.00 – 15.00

Standard penetration tests

Standard penetration tests (SPTs) were completed within all boreholes at depth intervals of about 1.5 metres at shallow depths (less than 16 metres) and at 3.0 metre intervals at greater depths (greater than 16 metres).

SPT results show a general trend of increasing density/soil stiffness with depth to about 10 metre depth below ground level. Beneath this depth, results tend to be within a more constant range.

A total of 15 tests reached effective refusal with blow counts exceeding 50 without a full 300millimetres depth of penetration being achieved. Examination of the soil recovered from the SPT tip from these tests, and subsequent boring, indicated that these were generally located within gravel bands.

Groundwater

The method of drilling using mud below the upper few metres precluded detailed observation of groundwater. However, groundwater was observed at a shallow depth of about one metre within BH03 during drilling.

Two standpipes were subsequently installed to allow measurement of groundwater:

- BH02 – measured five days after drilling at a depth of 1.82 metres below surface
- BH05 – measured one day after drilling at a depth of 2.22 metres below surface.

Laboratory testing

Laboratory testing was carried out on selective soil samples.

A total of 18 tests were carried out across the five boreholes for the purposes of soil classification and included Atterberg limits, moisture content and linear shrinkage.

An additional two tests were carried out for one-dimensional consolidation on undisturbed ‘push tube’ samples from BH01 and BH03. Consolidation of up to 16.9 per cent was recorded.

Further point load testing of rock cores retrieved from BH03 and BH04 was completed. The results of these tests are provided in table 5.4 below.

Table 5.4: Point load testing results

BH ID	Depth (m)	Equivalent UCS (MPa)	Strength Description
3	26.95	12	Medium
	27.95	126 – 137	Very High
	28.85	102 – 161	Very High
4	32.95	51 – 56	High
	33.95	19 – 39	Medium – High
	34.95	48	High
	35.45	53 – 66	High

Bridge foundations

The presence of low strength soils and uncontrolled fill near the surface, and the expected high magnitude of bridge loadings are likely to preclude the use of shallow footings for the bridge structures. A piled bridge is considered the most practical approach to the design and construction of all of the options.

Piles solutions that extend through the sequence of alluvial and residual soils found on rock offer the most robust solution. However, the depth of rock along the southern side of the railway is known to be about 24 to 32 metres deep. At other borehole locations rock was not encountered, despite drilling in excess of 20 metres in all locations. As a result end bearing piles founded on rock are unlikely to be economical for this project and floating piles may offer a better overall solution.

Earthworks

The stability of temporary batter slopes and excavations may be variable, due to the potential variation in soil composition and groundwater ingress. Shallow angle slopes no steeper than 1.5H:1V should be adopted for temporary excavations or trench support should be utilised.

Embankment batters may be designed to be no steeper than 2H:1V as part of the concept design, subject to further refinement as the design progresses.

Contaminated soils

There is a risk of contaminated soils within the study area, due to historical filling at adjacent light industrial/commercial sites, potential hydrocarbon contamination around two fuel depots and

potential hydrocarbon, heavy metals, asbestos and other contamination associated with train operations along the rail corridor. There were no additional indicators of contamination following the site investigation that was completed.

Geotechnical considerations – Option A

The following geotechnical issues have been identified for Option A:

- Potential settlement of earth approach embankments and abutment retained soil walls. Some ground improvement may be required
- Increased loading of the culvert at the southern end of New Street. Detailed assessment of this structure would need to be carried out
- Significant depth to bedrock which may preclude the use of end bearing piles founded on rock
- Piling works close to residential properties, with associated noise and vibration issues
- Constrained working areas, especially for construction of approach embankment retained soil walls at the northern end of the alignment
- Loading of potentially compressible soils within the eastern spur of Blackjack Creek at the southern end of the alignment, as part of the roundabout reconfiguration. Ground improvement may be required and scour protection should be considered.

Geotechnical considerations – options B and C (Refined)

The following geotechnical issues have been identified for Options B and C (Refined) as they contain a similar horizontal alignment west of the Mill:

- Route alignments conflict with several major buried services easements, as well as the 'Ashfords Water Course' drainage channel. Service relocation or protection will be required. Localised realignment of the drainage channel may be needed
- Significant depth to bedrock (bedrock not proven away from central span over the rail line) may preclude the economic use of end bearing piles founded on rock
- Piling work close to residential properties at the northern end of the alignment, with associated noise and vibration issues
- Potential settlement of earth approach embankments and abutment retained soil walls. Some ground improvement may be required, particularly north of the rail line
- Construction close to Blackjack Creek:
 - Loading of potentially compressible soils. Ground improvement may be required and scour protection should be considered
 - Creek embankment stability

- Stability and founding levels of retained soil walls
- Construction access when working from the creek bed.

Existing road safety audit

A stage 5 (existing conditions) Road Safety Audit was completed for the area between the Oxley Highway/New Street roundabout and the Warrabungle Street/Kamilaroi Highway intersection. The audit was done between 3 June 2013 and 4 June 2013 and has been used to inform the project of existing road safety issues that may lead to design improvements of the recommended option.

The extent of the road safety audit has been illustrated in figure 5.4 below.

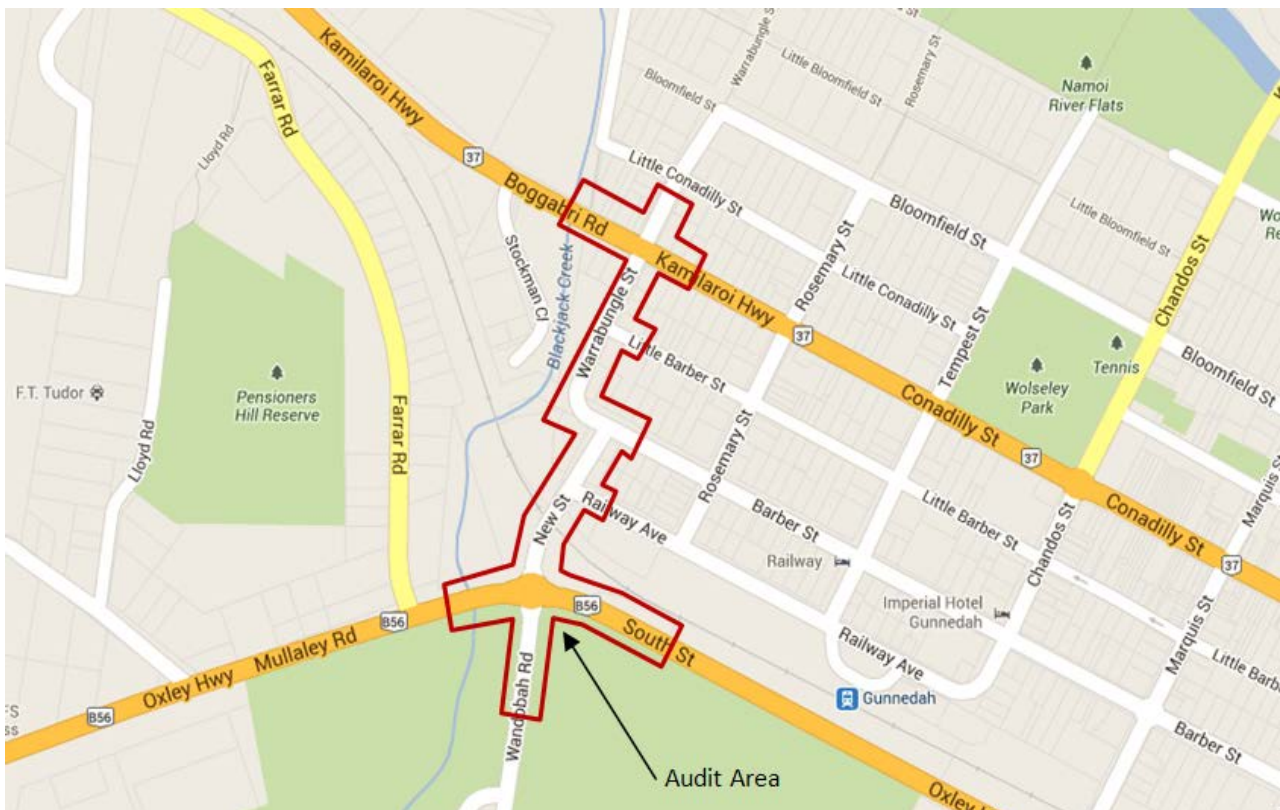


Figure 5.4: Road safety audit extent

Extents of audit

The key road safety elements that were examined as part of the audit process included:

- Path width and quality
- Kerb ramps and transitions
- Pedestrian crossings and fencing
- Fixed items adjacent to the roadway, including trees and electricity/light poles
- Roadside hazards

- Adjacent land use access points
- Sight distance and visibility
- Intersection layout and geometry
- Signage and line marking
- Vehicle turning paths
- Pavement condition, including presence of loose material
- Lighting.

Results

Several general observations were made during the road safety audit. These have been outlined in table 5.5 below.

Table 5.5: Existing road safety audit general observations

Item	Description of Observation
1	No pedestrian facilities are provided on New Street, Warrabungle Street or at the roundabout of South Street, Mullaley Road, New Street and Wandobah Road.
2	During the daytime site visit, two trains were observed crossing New Street. These trains took an average of 5:23 minutes (start to stop of bells) to pass through the crossing.
3	The following traffic behaviour was observed during the above train movements: A queue of up to 16 vehicles south of the crossing. The queue extended through the roundabout onto Oxley Highway A queue of up to 30 vehicles north of the crossing. The queue extended onto Barber Street Vehicles approaching the crossing from the south undertook three point turns or diverted via Railway Avenue to access alternative crossing points.
4	Road line markings (edge line marking, intersection holding line etc.) are not provided at several locations.
5	In general, the line marking and delineation is of poor quality on all roads within the audit area.

In addition to the general observations made above, a total of 66 deficiencies in the existing road network were identified in the vicinity of the three shortlisted options. Of these, 21 were assessed as being high risk issues. As the majority of the issues were not related to the project, the report has been forwarded to Gunnedah Shire Council to address the identified deficiencies.

Table 5.6 provides a summary of high risk issues that are relevant to this project and the shortlisted options.

Table 5.6: Existing road safety audit - high risk deficiencies

Audit Ref #	Location	Deficiency / Non-conformance	Risk
24	Left hand corner into New Street from Mullaley Road	Due to a narrow entrance to the roundabout, large vehicles (B-doubles) appear to have made contact with or have driven over the inside kerb. Significant damage to the kerb and adjacent verge was observed. Trucks undertaking this turn could mount the kerb and hit pedestrians.	High
25 / 26	New St – 20m north of Oxley Highway	An unprotected culvert is located within the clear zone on the east and west sides of the road. Errant vehicles could cross the verge and fall into the drainage channel below.	High
33	Railway crossing	The pavement quality on the pedestrian crossing of the rail line is uneven and has multiple trip hazards. Pedestrians (especially less mobile pedestrians) using the crossing could trip or fall.	High
37	New Street at Barber Street	There is no clear delineation or signage of vehicle priority at the intersection. Observations indicated that vehicles within New Street fail to slow down and give way at the intersection. This could lead to a side impact collision.	High
48	Corner of Barber Street and Warrabungle Street	No street lighting is provided at this corner. Given the sharp turn and lack of delineation, this corner is considered unreadable at night at normal travel speeds. Drivers may not see the corner and continue straight into Blackjack Creek or nearby buildings.	High
55	Southern side of Kamilaroi Hwy	A pedestrian path is located on the southern side of the road. Due to the width of Warrabungle Street, pedestrians could take some time to cross the road. This in addition to the high heavy vehicle volumes increases the risk of a pedestrian being struck crossing the road.	High

The locations of the high-risk deficiencies are shown in figure 5.5.



Figure 5.5: High-risk deficiencies and non-compliances

Where appropriate these deficiencies have been incorporated into the design development of each concept option. These will be further refined during the detailed design process for this project.

A further road safety review was completed on each of the three shortlisted options as part of the assessment process. This review is discussed in section 6.3.

Traffic analysis

Traffic modelling was done to inform the development of the three concept options and to provide a basis from which to assess the need for upgrading intersections in the vicinity of the rail crossing.

Sidra Intersection software models were prepared to assess the traffic flow and connectivity advantages and disadvantages for each option.

Base case and future year intersection models were prepared for the following intersections:

- New Street/View Street/Oxley Highway/South Street intersection
- Kamilaroi Highway/Warrabungle Street intersection.

Peak PM traffic models were then prepared for multiple scenarios, which included:

- 2013 – existing base case

- 2016 – opening year with new bridge
- 2026 – 10 years after bridge opening
- 2036 – 20 years after bridge opening.

The models were based on the traffic flow assumptions and key findings in the Gunnedah Traffic Study – Review of Road Network at Rail Crossings prepared by GHD in 2012, supplemented by traffic counts carried out in March 2013.

Results

Table 5.7 presents the modelling results for each intersection and scenario, with the average vehicle delay in seconds and corresponding level of service assessment determined for each option.

Table 5.7: Sidra Intersection traffic analysis results

Year	Option A		Option B		Option C (Refined)	
	Vehicle Delay	Service Level	Vehicle Delay	Service Level	Vehicle Delay	Service Level
New Street / View Street / Oxley Highway / South Street Intersection						
2013	11	A	11	A	11	A
2016	12	A	12	A	14	A
2026	13	A	13	A	14	A
2036	19	B	19	B	20	B
Kamilaroi Highway / Warrabungle Street Intersection						
2013	14	A	14	A	14	A
2016	17	B	391 (11)	F (A)	17	B
2026	60 (11)	E (A)	(12)	(A)	60 (11)	E (A)
2036	(12)	(A)	(14)	(A)	(12)	(A)

The key results indicate that all three options would result in satisfactory performance at the New Street / Oxley Highway roundabout.

The higher volumes of traffic on Warrabungle Street for Option B are due to the closure of the New Street rail crossing. This would result in the Kamilaroi Highway / Warrabungle Street intersection operating at a level of service rating of 'F' in the year the proposed bridge opens in 2016.

The figures presented in brackets for the Kamilaroi Highway/Warrabungle Street intersection represent the traffic efficiency results for the intersection based on a suitable intersection treatment being constructed to improve traffic flow. For the Option B scenario, construction of a roundabout would improve the 2016 result to a level of service of A.

The Option A and Option C (Refined) alignments would reach a level of service of E by 2026 at this same intersection.

Flood analysis

Existing flooding conditions

Blackjack Creek drains runoff from a catchment area of approximately 24 square kilometres to the Oxley Highway over a length of eight kilometres between the upper reach catchment boundary to the cross drainage structures at the Oxley Highway. The creek then discharges to the floodplain of the Namoi River.

A flood study of Blackjack Creek was completed by Lyall & Associates Consulting Engineers in 2005 and was used as an input into the 100 year ARI flood extents map that forms part of the Gunnedah Local Environmental Plan. Figure 5.6 illustrates the 100 year ARI flood extents in the study area.

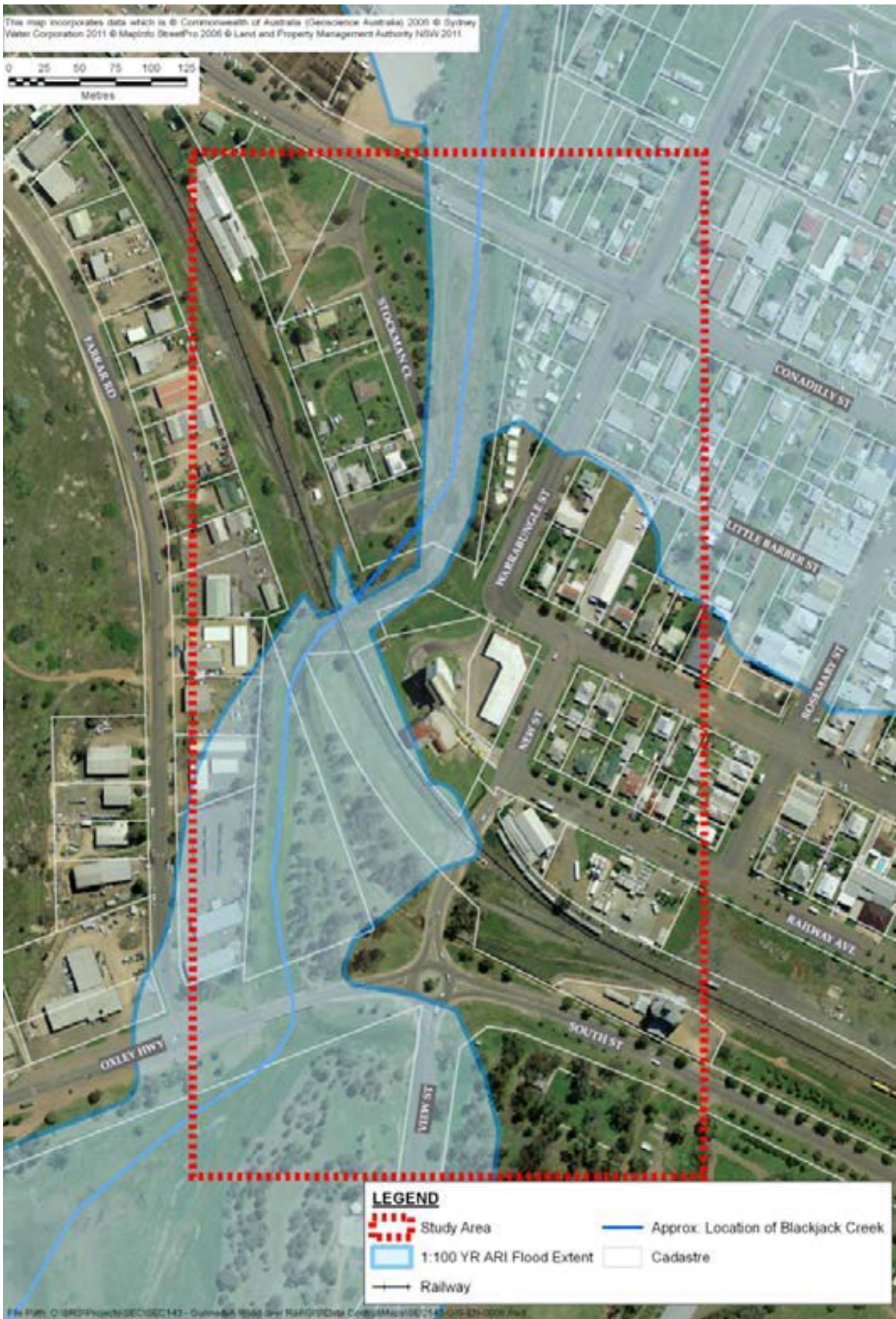


Figure 5.6: 100-year ARI flood extents in study area

Flood modelling

To quantify the impact each option has on the existing flood conditions, a flood modelling exercise was carried out on Blackjack Creek.

Some components of the original flood model were made available to the project team. Where appropriate, this information was utilised to maintain consistency with previous work, however, this was limited to:

- Channel cross section geometry upstream of the Oxley Highway culverts
- Catchment delineation information.

An open channel flood model was generated using the HECRAS software package for the entire length of Blackjack Creek to a point about 70 metres downstream of the Kamilaroi Highway crossing.

Cross sections were developed to simulate each option, under two construction scenarios:

- Maximum viaduct construction with reinforced soil walls provided up to no more than four metre height
- Maximum reinforced soil wall construction with the minimum opening for the ARTC rail clearances.

These two scenarios have been developed to determine the sensitivity of the options to the differences in construction technique in order to inform the project and assist in determining the most efficient form of construction.

Results

The modelling results for each concept option focussed on two key parameters:

- Afflux
- Flow velocity.

The afflux is a measure of the change in flood elevation due to the building of the bridge. Criteria for allowable afflux values differ but for the purposes of selection of a recommended option, the following guide has been utilised:

- For land within the project corridor or owned by Roads and Maritime should be no more than 200 millimetres
- For land outside the project corridor not owned by Roads and Maritime should be no more than 50 millimetres
- For land where buildings or sensitive structures exist that were not previously inundated but would be at increased risk of inundation should not be more than 0 millimetres.

The flow velocity is used primarily to identify potential scour issues at bridge and embankment support structures. A value exceeding two metre per second is typically enough to produce scour.

The results of the flood modelling process are summarised in table 5.8 below.

Table 5.8: Flood modelling results

Option	Afflux (mm)	Flow velocity (m/s)
Option A (viaduct)	0	N/A
Option A (retaining wall)	0	N/A
Option B (viaduct)	6	0.53
Option B (retaining wall)	20	0.55
Option C (Refined) (viaduct)	11	0.53
Option C (Refined) (retaining wall)	16	0.56

Based on the results of this modelling work it is apparent that a viaduct solution will pose a minimal flooding risk to the project for any of the options.

5.4 Refinement of shortlisted options

Road geometry

The following guidelines have been used as the basis for developing the designs for each option:

- *Austrroads Guide to Road Design* (Roads and Maritime, 2009)
- *Roads and Maritime Supplements to Austrroads Guides* (Roads and Maritime, 2009).

Table 5.9 provides a summary of the key design criteria used in developing the geometric alignments for the three options.

Table 5.9: Road design criteria

Design Criteria	Design Requirement
Horizontal alignment – design speed	50 km/h
Vertical alignment – design speed	50 km/h
Minimum horizontal curve radius	60m
Minimum vertical curve	Crest 520m Sag 400m
Crest 'K' parameter	9.3
Sag 'K' parameter	6
Lane width	3.5m
Maximum vertical grade	10%
Minimum sight distance	48m
Design vehicle	B-double
Check vehicle	B-triple

Design speed – 50 kilometres per hour

The *Preliminary Concept Options Report* (Roads and Maritime, May 2013) identified a 60 kilometre per hour design speed be applied for the design of each concept option.

After further review of the broader traffic conditions around Gunnedah (to provide some context for the original speed limit requirement), it was determined that a speed limit of 50 kilometres per hour more suitably fit with the broader system of roads in the town. The alignments were therefore optimised to meet the requirements of a 50 kilometres per hour horizontal and vertical design speed.

The benefits of this change include a bridge width reduction due to sight distance criteria changes and reduced land resumption.

Shared path

The *Preliminary Concept Options Report* (Roads and Maritime, May 2013) identified a 2.5 metre wide shared path for use by pedestrians and cyclists.

Following an assessment of the likely pedestrian desire lines and observed usage of the existing level crossing, it was determined to be unnecessary to construct a path of this width for the following reasons:

- Pedestrian volumes at the existing level crossing were observed to be low
- Approach and exit grades on each concept option are steep

It was agreed that a reduced width footpath on the bridge of 1.8 metres wide be utilised for each of the options. However, following the decision to close the level crossing to pedestrians and cyclists, a 2.5 metre wide shared path will be incorporated on the bridge. An alternative crossing is available for pedestrians and cyclists at Marquis Street level crossing which will be upgraded by ARTC.

A 2.5 metre wide footpath will be provided on sections of road with standard earthworks as illustrated in figure 5.7.

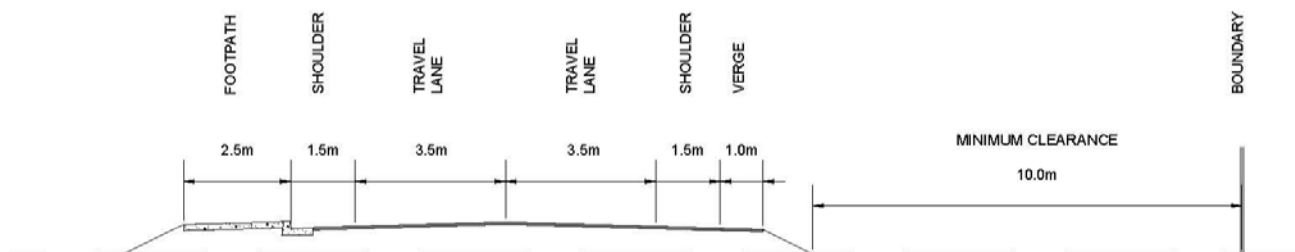


Figure 5.7: Typical road cross section

Pavement design

In consultation with Roads and Maritime and Gunnedah Shire Council, an indicative pavement design was developed for the purposes of doing a comparative assessment of the options. This pavement is typical of designs for similar Roads and Maritime roads in the region and is illustrated in figure 5.8.

Note that a CIRCLY pavement design software model and design were developed during the design optimisation phase of the project, as outlined in section 8.2.

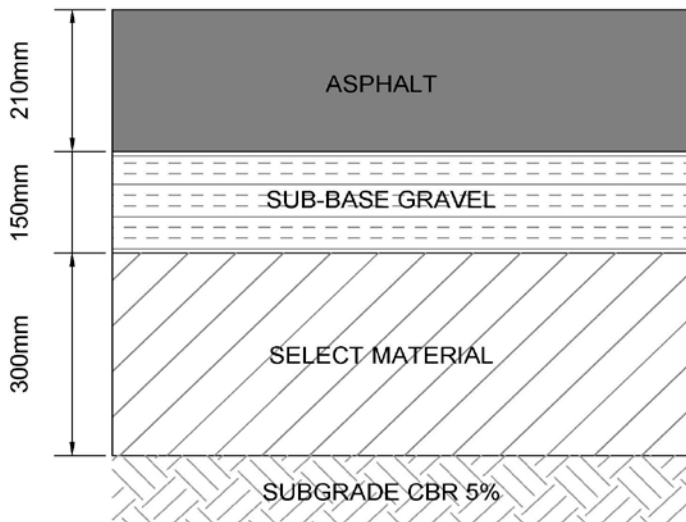


Figure 5.8: Preliminary pavement cross-section design

Intersection upgrades

Oxley Highway/New Street

The existing roundabout at Oxley Highway and New Street requires upgrading for all options. The modifications required to the roundabout are outlined below.

Option A utilises the existing roundabout, but modifies it to accommodate the B-double turning paths.

Option B also utilises the existing roundabout and is very similar to the four-leg roundabout in Option A.

Option C (Refined) utilises the existing alignment of View Street and New Street, but is a roundabout with five legs to provide access to New Street if required.

Conadilly Street/Kamilaroi Highway/Warrabungle Street

The existing intersection at the Kamilaroi Highway consists of a give way intersection with priority given to vehicles moving east-west on the Kamilaroi Highway.

The traffic modelling indicates that an upgrade of this intersection will be required from a give way control to a roundabout for each option.

Figure 5.10 illustrates an HML and B-double compliant roundabout that will be suitable for each concept option to accommodate the increases in future traffic demands.

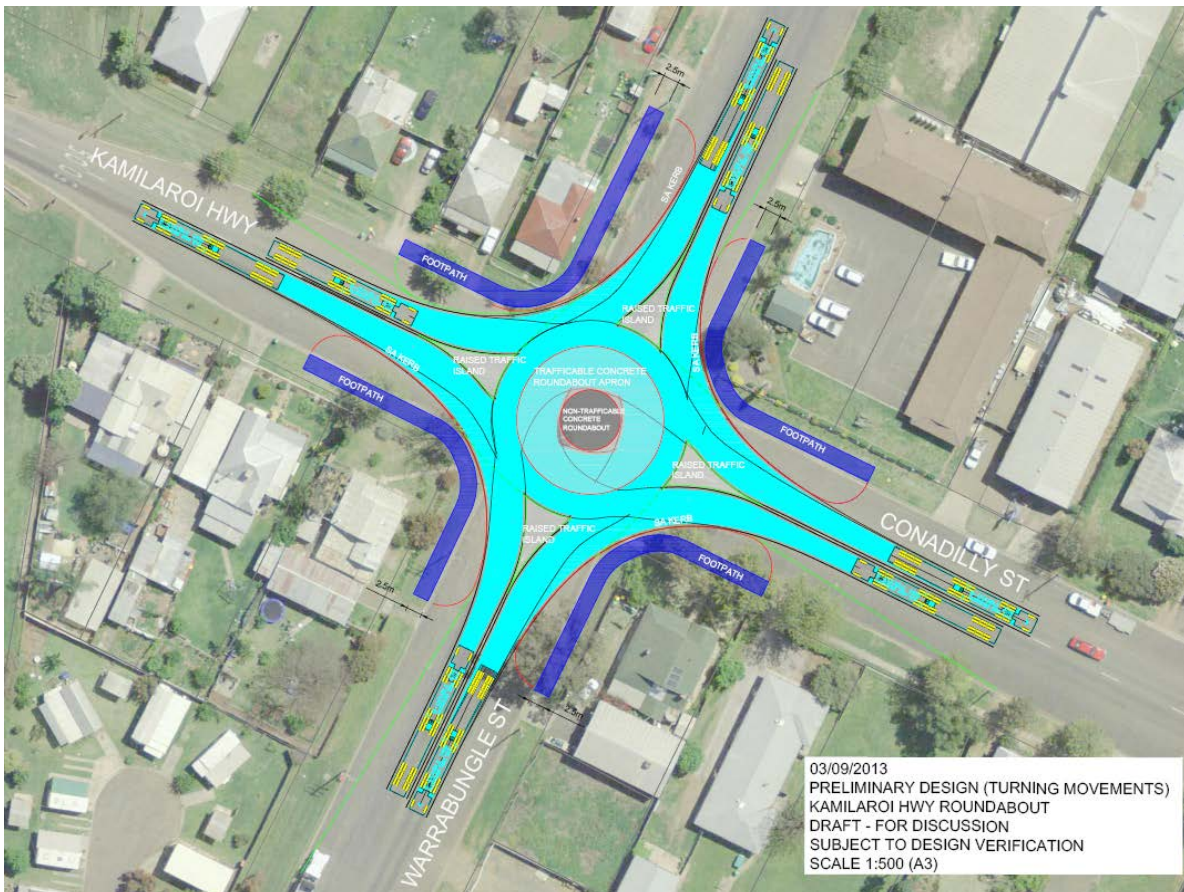


Figure 5.9: Proposed intersection upgrade - Kamilaroi Highway/Warrabungle Street

Bridge design and construction

Given the site constraints, a number of bridge forms and materials are considered suitable for the new bridge. These structural forms have been considered during the option development phase, and a preferred structural form arrived at. Typically, each of these structural forms can be applied to all options, with the exception of an incrementally launched bridge, which requires a straight alignment, or a constant radius. Each of the structural forms considered are discussed below, with commentary on their suitability to this specific bridge.

Super-T girders

Super-T girders are a precast, prestressed concrete girder commonly used in bridge construction. Economical spans for super-tee girders are in the range of 20 to 35 metres, with varying girder depths from 1200 to 1800 millimetres typically used. Their precast nature allows for some flexibility in the bridge curvature that can be incorporated into the design (i.e. girder flanges can be tapered or curved to suit specific bridge geometry), however, due to the prestressing excessive asymmetry should be avoided. Additionally, extreme skew angles, being the angle between the orientation of the centreline of the girders and the centreline of the supporting pier, should be avoided and is limited by Roads and Maritime design rules. However, by adjusting skew and incorporating excess deck area, most geometries can be constructed using Super-T girders.

Super-T girders are a composite section and require insitu construction of the bridge deck to occur after all girders in a span have been installed. The bridge deck, and associated hogging of the girders can add about 400 millimetres to the structural depth of the bridge.

These girders can weigh between 40 and 80 tonnes depending on the length of the girders and require medium to heavy lift cranes to lift them into place, depending on the constraints associated with the crane location and the delivery of the girders.

The construction methodology is well understood and does not require specialist technology to construct. The concrete girders can be precast offsite and delivered to site as required to suit the installation timing. Given the nature of the site it should be possible to configure the delivery of the girders and the crane locations to provide an economic lifting methodology.

This is the adopted structural form for the project from a cost and constructability point of view. Figure 5.11 illustrates a typical Super-T girder lift.



Figure 5.10: Typical super-T girder construction

Insitu voided slab

An insitu concrete voided slab is generally a structurally more efficient form than the Super-T girders. This efficiency means that it can be constructed to span longer distances with a thinner structural depth than the Super-T girders. However, this efficiency is achieved through significant insitu works.

A voided slab is cast insitu, to the required geometric profile, on false work and formwork. This supporting structure increases the structural depth during building, meaning that for alignments that are constrained by a required minimum clearance, this temporary structural depth needs to be incorporated into the alignment design. Additionally, when compared with the onsite works for a Super-T the build duration is longer, as well as substantially increasing the construction interface and difficulties over the rail corridor.

The means of achieving the longer spans, for thinner section is through post-tensioning of the concrete slab. This post-tensioning is a specialist activity that is done by a relatively limited number of contractors, when compared with general concreting activities. In addition, due to the nature of post-tensioning small radius curvatures are avoided, as this can cause a number of secondary effects in the bridge that will be required to be overcome or they may compromise the long-term durability of the structure.

Given the above factors, an insitu voided slab is not considered suitable for this project.

Incrementally launched bridge

In areas where access is limited, or a particularly long span structure is being built, a bridge can be built and incrementally launched. For an incrementally launched bridge, the structure is built from one end, section by section and pushed into place progressively. This form of building is very specialised, and requires significant staging to ensure temporary load effects are considered and incorporated into the design.

Typically, incrementally launched bridges would have a box-type construction, which would require access through the internal box for future maintenance inspections. This maintenance access requirement would typically mean a structural depth of at least 2.5metres.

Given the access along the bridge and vertical alignment constraints, it is not considered that an incrementally launched structure would be appropriate for this location.

Steel girders (plate or box)

Due to the material properties of steel, it is considered a more flexible structural material than concrete, and can typically achieve larger spans than concrete structures for an equivalent structural depth. However, due to the potential for corrosion of steel structures they require ongoing protection during the usable life of the structure which can increase the whole-of-life costs relative to concrete structures.

Steel bridges can be built as either L-girders or box girders, built using welded plates. In NSW there are only two Roads and Maritime qualified steel fabricators who could be used for the fabrication of a steel bridge. Steel bridges will also require on-site fabrication to weld the individual sections together after delivery to site, and before lifting into place.

It is unlikely that a steel bridge would be an appropriate solution for this project.

As discussed in section 5.3, a piled foundation solution is likely to be adopted for the structure. A piled foundation may require a pile cap in order to transfer load appropriately through the foundation structure. A high water table would mean that options for founding that do not rely on pile caps may be preferable.

The likely adoption of Super-T girders forming the superstructure, requires a headstock to be used to transfer load effectively from the superstructure to the substructure. Figure 5.12 illustrates a likely typical cross section for the viaduct. Note that this has been developed further (refer to section 8.3)

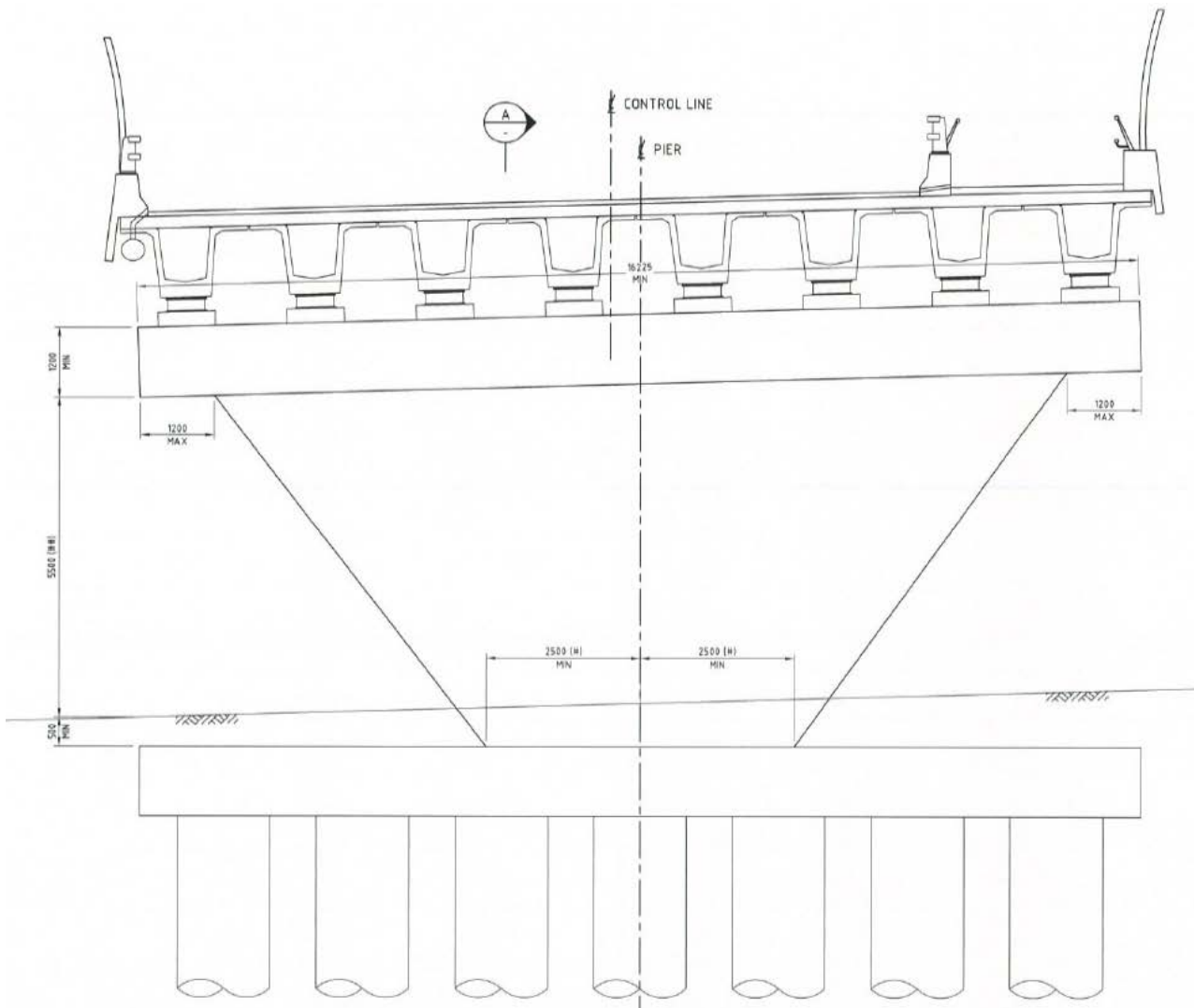


Figure 5.11: Typical bridge cross section

A number of substructure solutions have been considered. Typically, they have involved consideration of a solid pier arrangement, connecting a pile cap to the headstock, or they involve consideration of discrete columns connecting individual piles to the headstock.

A solid pier with associated headstock and pile cap has the advantage of being able to easily incorporate any construction tolerances that may arise such as out-of-straightness or offset from design position for the piles. Additionally, the solid pier will be better able to absorb the load effects from rail collision that will be a consideration for the bridge supports either side of the rail corridor. The appearance of a solid pier can be softened through the use of a tapered profile, with minimum structural dimensions maintained to allow for sufficient reinforcement and connection between each of the structural elements. The inclusion of a void in the centre of the otherwise solid pier has also been reviewed, allowing for visual access through the centre of each pier. This has been assessed from a structural perspective and can be accommodated with additional reinforcement.

The alternative to a single pier support is to use several individual columns, connected directly to either discrete piles, or a pile cap. The columns would be connected at the top via the headstock, which supports the superstructure. The connection between the piles and columns would have to allow for any out-of-straightness of the installed pile to be corrected, which is achievable by selecting a column size with a footprint smaller than that of the pile. Any profile shape can be adopted for the column, subject to consideration of the final design loads to be considered.

Urban design

Specific urban design principles have been adopted to guide the design process and mitigate visual and landscape characteristics. The following considerations have been made in the development of the three shortlisted options:

- Design a structure that is aesthetically resolved without visually dominating the setting
- Consider a superstructure with clear lines that does not visually compete with the Mill
- Avoid visual clutter and keep the singular components of the structure simple and legible
- Place piers on natural or man-made promontories where possible to keep piers shorter and better integrated with the setting
- Develop a pier shape that minimises the footprint to mitigate flooding impact
- Space piers so that the ratio of pier height is similar, as much as practical between spans, as this will provide a more unified composition
- In the case of curved alignments, position piers so that they relate to the alignment, or use circular piers
- Retain a simple configuration of the overall structure
- Start the bridge structure when three to 4.5 metre clearance under the structure can be achieved. Introduce retaining structures at abutments as required. This will give the structure an open appearance while minimising concealed dark spaces.

Two examples of a bridge design that incorporate some of the above principles are illustrated in figure 5.13.



Figure 5.12: Bridge design examples utilising positive urban design principles

As part of the development of each of the options, a preliminary pier configuration has been proposed. It is illustrated in figure 5.14 below. This configuration will be reviewed and developed further for the recommended option during subsequent design phases of the project.

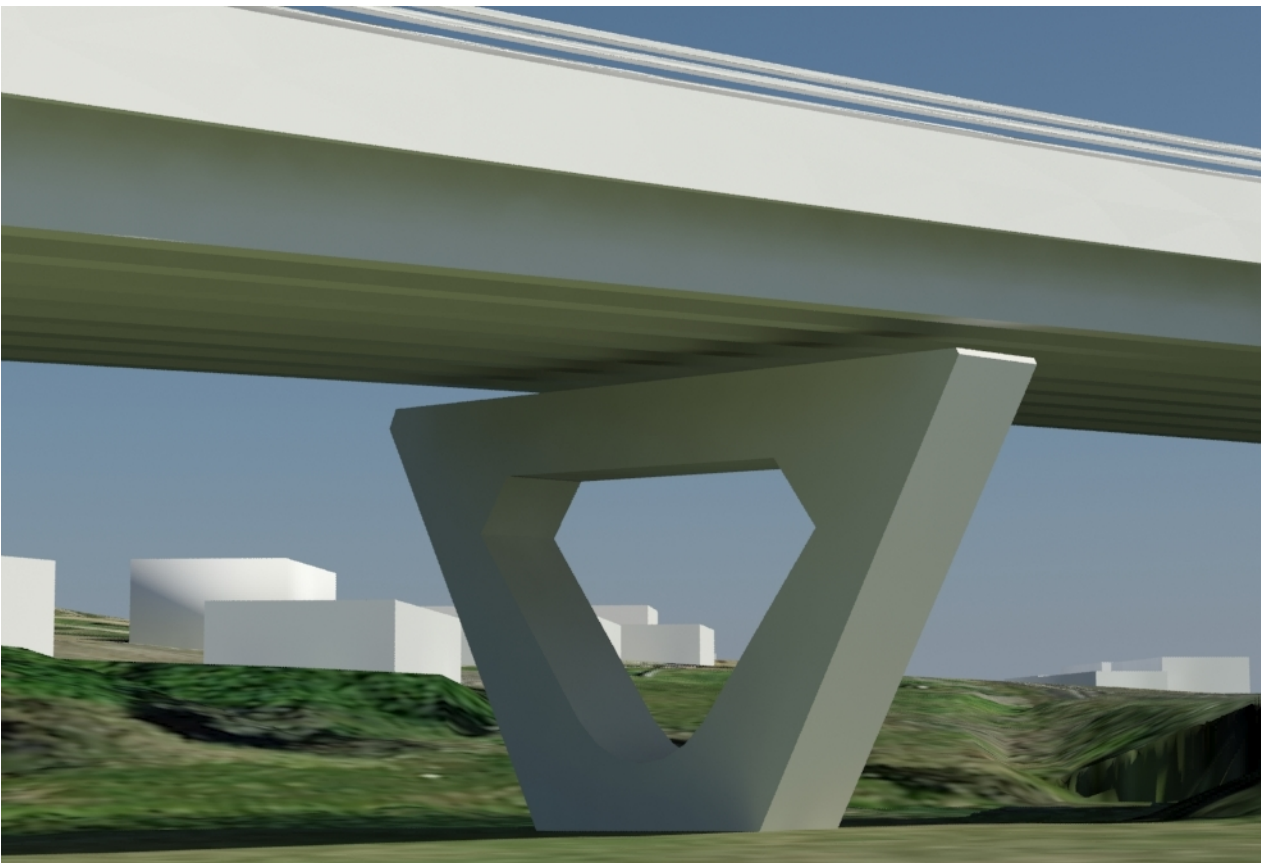


Figure 5.13: Proposed potential pier configuration

Utilities identification and consultation

The utilities identification and relevant authority consultation to date are summarised below:

- Dial Before You Dig search across the study area, updated in August 2013
- Consultation with Gunnedah Shire Council on the stormwater, sewer, water main assets, with particular focus on the major 500millimetre ductile iron concrete lined (DICL) water

main within the study area

- Determination of asset location from the detailed topographic survey done for Roads and Maritime by Moultrie Group
- Contact with the Technical Advisory Branch of Essential Energy about its current and proposed power poles and streetlights where they are likely to affect the proposed options alignment.

Utilities impact and proposed design where proposed options are affected

Table 5.10 below summarises the potential utilities impact and the design response based on the investigation and consultation to date.

Table 5.10: Existing utilities within project study area

Utilities	Description and impact on proposed options	Design response and approach
Major water rising main	The 500 mm diameter DICL water rising main and a smaller main run behind the Mill (refer to figures 5.16 – 5.19). This major asset has the following impacts on: * Option A – nil * Option B – some 180 m impacted * Option C (Refined) – major impact on majority of route	Design development, particularly the change to 50 km/h design speed, has allowed optimisation to minimise the co-alignment with the main. Discussions with Gunnedah Shire Council indicate that relocation along the affected alignment is the desirable solution, particularly for future maintenance access and this is allowed for. This includes a 150mm diameter uPVC golf course supply pipe laid in the same trench as the rising main.
Water main	The 100 mm and 150 mm diameter water mains were identified under Railway Street, Warrabungle Street, Barber Street, Stockman Close, New Street and the floodplain.	Due to the relatively small sizes of the pipes, these are considered only a minor constraint and allowances for relocation have been made.
Sewer	The 150 mm and 225 mm diameter sewer mains were identified under Railway Street, Warrabungle Street, Barber Street, Stockman Close, New Street and the floodplain.	Due to the relatively small sizes of the pipes, these are considered only a minor constraint and allowances for relocation or protection have been made.
Stormwater	Stormwater pipes and pits along local streets were identified in the vicinity of the study area.	Due to the relatively small sizes of the pipes, and the fact that road improvements will require upgrades to the stormwater network as part of the works

Utilities	Description and impact on proposed options	Design response and approach
		and is allowed for
Telecom	Telstra cables, electrical poles and underground earth wires were identified in the vicinity of the study area.	These assets present a minor constraint and relocations are allowed for.
Power supply and streetlights	<p>Up to 18 power poles/streetlights are likely to be affected by the proposed works.</p> <p>The impacts can be summarised as follows:</p> <p>Option A – major, due to roundabout raising and reconstruction.</p> <p>Option B – minor, as the roundabout works are minimal.</p> <p>Option C (Refined) – major, due to roundabout reconstruction.</p>	Relocations have been allowed for. Option A includes an allowance for potential two stage operation to allow for raising and filling of earthworks at roundabout and then moving back once complete.

Further refinement and confirmation of service agencies requirements will be carried out during the next phase of design.

Constructability

Bridge and road design optimisation constructability meeting.

The objectives and outcomes of bridge and road design optimisation constructability are set out below.

Viaduct versus wall length and bridge spans design basis

The viaduct versus wall consideration was considered a key design strategy decision for the project team. To address this, presentations were provided by the discipline specialists from the structural and road design, geotechnical, flood, comparative cost, urban design, ecology, community, environmental and land resumption constraints point of view.

Key inputs and recommendations included:

- Recent cost estimate review indicated that viaduct becomes more economical than reinforced earth walls above approximately three metre to four metre height
- Visual permeability of the structure (i.e. viaduct in lieu of wall) and balance are the key urban design objectives within the location, particularly as a majority of walls would have an undesirable impact on the Mill, with a 4.5 metre maximum wall height suggested
- Walls should not be less than three metres, because dark undesirable places are then created

- Geotechnical investigations foundation conditions indicated that walls over four metres are undesirable.

It is recommended that the maximum wall height should be between three metres and 4.5 metres, with due consideration of the multi-discipline constraint inputs above. This outcome provides a balanced and well founded solution satisfying bridge design, cost, urban design and geotechnical considerations.

Constructability workshop

A constructability workshop was held in September 2013 with an external facilitator to identify critical constructability issues that either need to be considered in the options assessment or addressed in future design phases.

Some of the main issues which were identified during the workshop are set out in section 6.2, which covers the constructability assessment, within the context of each shortlisted option.

Shortlisted concept options

The developed shortlisted concept options have been illustrated in figures 5.15 to 5.18 for single and double stacking.

Key features for the **single stack version of Option A**:

- Upgrade existing roundabout on Oxley Highway in same location, raised 1.2 metres
- No immediate upgrade required at Warrabungle Street and Kamilaroi Highway
- Construction to consist of a combination of viaduct and soil earth walls with viaducts starting when the alignment reaches about four metres above the existing ground
- Access to the Mill from New Street will be via Railway Avenue underneath the viaduct with a 4.6 metre vertical clearance provided
- New Street level crossing is closed to vehicles and pedestrians. A footpath would be provided on the bridge to accommodate pedestrian movements.

Key features for the **double stacking version of Option A** are the same as for the single stacking alignment with the following exception:

- The roundabout on Oxley highway is shifted south and raised by about 3.4 metres to achieve vertical grades.

Key features for the **single and double stacking alignments of Option B** are equivalent and include:

- Upgrade existing roundabout on Oxley Highway in same location, same level
- Immediate upgrade required at Warrabungle Street and Kamilaroi Highway intersection
- Construction to consist of a combination of viaduct and soil earth walls with viaducts

starting when alignment reaches about 4 metres above the existing ground

- New Street level crossing will be closed to vehicles but open to pedestrians and cyclists (subject to ARTC approval). A footpath would be provided on the bridge to accommodate pedestrian movements.

Key features for the single and double stacking alignments of Option C (Refined) are equivalent and include:

- Upgrade existing roundabout on Oxley Highway with a five-leg roundabout utilising existing alignments of all approach roads at the same level
- Construction to consist of a combination of viaduct and soil earth walls with viaducts starting when alignment reaches about 4 metres above the existing ground
- The design at this stage of development accommodates the New Street level crossing to remain open or closed for vehicular traffic, but open to pedestrians and cyclists (subject to ARTC approval). A footpath would be provided on the bridge to accommodate pedestrian movements.

Subsequent to value management workshop, additional design optimisation work was undertaken on Option C (Refined). The results of this investigation are outlined in section 8.2.



Figure 5.14: Option A (single stacking clearance)



Figure 5.15: Option A (double stacking clearance)



Figure 5.16: Option B (single and double stacking clearance)

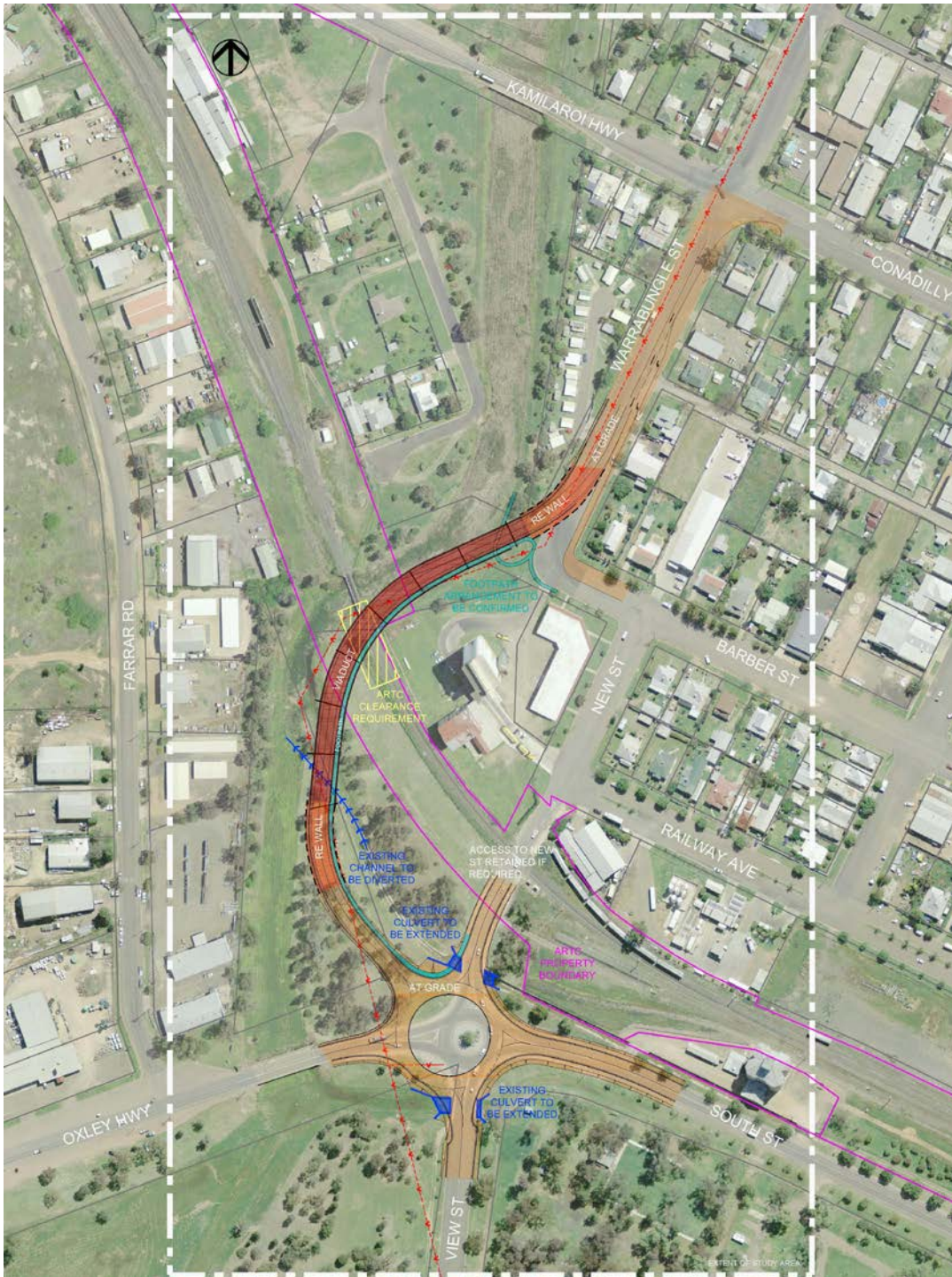


Figure 5.17: Option C (Refined) (Single and Double stacking clearance)

Note that at the shortlisted concept options project development phase the Option C (Refined) Oxley Highway design was for a four or five-leg roundabout, (level crossing open or closed), within the same configuration. At this point in the development process, the Barber Street connection was included in the five-leg roundabout.

5.5 Ecological sustainable development (ESD)

The objects of the *Environmental Planning and Assessment Act* 1979 (EP&A Act) under which all development is assessed in NSW, document a purpose of the Act as to encourage Ecologically sustainable development (ESD) (clause 5a (vii)). Roads and Maritime has also incorporated ESD within its management principles in the Roads and Maritime Environment Policy Statement 2012 (pg1) as follows:

‘Roads and Maritime will demonstrate due diligence in the provision of its services, manage its work activities in a manner which is consistent with the principles of ecologically sustainable development, and deliver continuous improvement in environmental performance...’

While the project is not yet at a formal assessment stage under the *Environmental Planning and Assessment Act*, it is pertinent to take proactive measures during the options assessment to demonstrate due diligence.

ESD principles

ESD is defined in schedule 2 of the *Environmental, Planning and Assessment Regulation 2000* (EP&A Reg.). It has four principles that are commonly referred to as follows:

1. the precautionary principle
2. intergenerational equity
3. the conservation of biological diversity and ecological integrity
4. improved valuation and pricing of environmental resources

A brief description of each principle is provided below.

1. Precautionary principle

The *Environmental, Planning and Assessment Regulation 2000* defines the precautionary principle as, ‘if there are threats of serious or irreversible environmental damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation’. Thus, the principle requires taking proactive measures to prevent harm to the environment in advance of scientific proof that such harm will occur.

2. Intergenerational equity

The *Environmental, Planning and Assessment Regulation 2000* states inter alia that intergenerational equity requires that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of ‘current and future generations’.

3. Conservation of biological diversity and ecological integrity

This principle requires that conservation of biological diversity and ecological integrity should be a fundamental consideration. The principle extends to the conservation of the total variety of life forms and biotic systems, including the diversity of genes, species, populations and their communities, as well as the ecosystems and habitats to which they belong.

4. Improved valuation and pricing of environmental resources

This principle requires placing a monetary value on the environment such that the environmental costs of service provision (arising from pollution and depletion of natural resources) can be calculated. This facilitates the application of mechanisms to control pollution and wasteful use of resources. Mechanisms for improved valuation and pricing of environmental resources include:

- The polluter pays principle; those who generate pollution and waste should bear the cost of containment and clean-up
- The consideration of the full life cycle costs of providing services (including the use of natural resources, the disposal of any wastes and the clean-up and repair of environmental damage).

Options assessment

The principles of ESD have been incorporated into the design development through the design optimisation process. They have also been applied as a mechanism to comparatively assess the feasibility of each option

Table 5.11 demonstrates how the consideration of the principles has been addressed in the development of each option for the purposes of comparing the options. Where further consideration of each principle is required in future environmental impact assessments this is also noted.

Note that the application of the principles is the same for double and single stack options and the table below assumes the same for both pairs of options as there is a negligible difference in potential environmental impacts.

Table 5.11: Application of ecological sustainable principles to each shortlisted concept option

Principle	Option A	Option B	Option C (Refined)
Precautionary principle	<p>Specialist environmental investigations have been undertaken which have determined with the best available scientific certainty potential impacts. Investigations to date show further studies are required to obtain scientific certainty for avoidance of environmental harm, in particular in the specialist areas of flooding/hydrology, and contamination (geotechnical).</p> <p>Future environmental assessments will ensure that any potential impacts will be fully investigated to complete due diligence.</p>	<p>As per Option A, however, further studies are required in particular in the specialist areas of flooding/hydrology, soils and ecology.</p>	<p>As per Option B.</p>
Intergenerational equity	<p>The proposed alignment has been optimised to ensure there is no reduction in beneficial use of existing land for future generations.</p> <p>Potential amenity impacts influencing the local area which can be mitigated through design have been considered within the options assessment during this preliminary phase through specialist investigations.</p> <p>Residual impacts will need to be investigated further and mitigated during the environmental assessment and concept design.</p>	<p>Initial investigations have determined that minor property acquisition is required. The design has been optimised to ensure that this does not reduce or limit the potential use of the remaining land for current and future use.</p> <p>The proposed option will result in a small reduction in beneficial use of open space within the study area, however, this has been minimised by optimising the design to ensure it meets urban design and visual landscape objectives.</p> <p>The health and diversity of the environment will be maintained provided the appropriate environmental measures to manage potential environmental</p>	<p>As per Option B, however, Option C (Refined) provides an alternative Option B which ensures that the heritage value of the Mill is further maintained for current and future generations.</p>

		impacts are in place during construction and operation to mitigate residual impacts.	
Conservation of biological diversity and ecological integrity	A detailed desktop and field investigation of the Biodiversity and Ecology of the entire study area and short-listed options has been undertaken. The specialist investigation of Option A showed that this option represents the least potential impact upon biodiversity and ecology.	As per Option A. The specialist investigation determined that there is likely to be a moderate potential impact upon the local ecology of the study area as a result of Option B. The investigation further determined that this impact can potentially be mitigated once further environmental assessment is undertaken.	As per Option B, however, the footprint is slightly larger than Option B, resulting in a negligible difference in impact.
Improved valuation and pricing of environmental resources.	Environmental costs and benefits of the project have been incorporated into the broader Economic Analysis for the project . The assessment has been undertaken to ensure that the costs to the environment have been quantified and included in the design options assessment.	Common to all options.	Common to all options.

6 Options assessment

This section outlines the process and criteria used to assess the three shortlisted concept options described in section 5 and present the findings of this assessment.

The aim of the assessment process is to identify a preferred concept option for further value management consideration and public consultation.

6.1 Assessment methodology

The process of assessing and recommending a preferred concept option was based on the principles of a Multi criteria analysis (MCA). This allows preferences to be objectively established between options using criteria relevant to the needs of the project and ensuring transparency.

An overview of the process is presented in figure 6.1 and is described further in subsequent sections of this report.

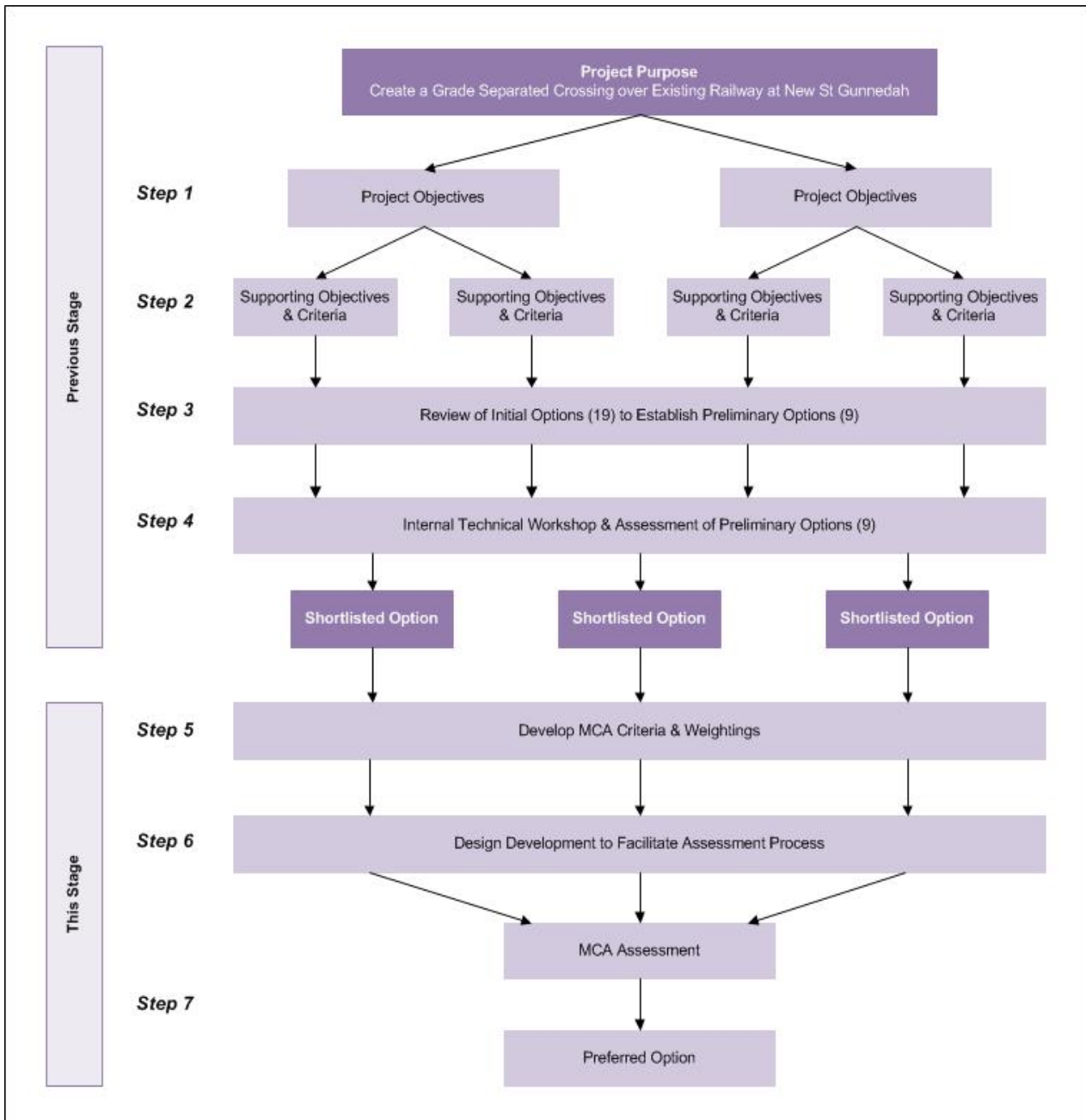


Figure 6.1: Assessment methodology process

Previous stage works – Steps 1 to 4

The project objectives that form the basis for the MCA assessment are outlined below:

- Provide a grade separated HML route through Gunnedah
- Improve local traffic efficiency/transport productivity and reliability
- Improve road safety
- Minimise the impact on the natural, cultural and built environment
- Provide value for money.

These objectives, together with the supporting objectives described in section 2.3, provided the general framework within which the preliminary options were reviewed and assessed.

An initial review of the original 19 preliminary options was undertaken to remove several that either did not meet the minimum design requirements or the objectives outlined above.

Nine options were subsequently retained for detailed assessment at the Internal Technical Workshop held in February 2013. This workshop was attended by 22 representatives from the project team, Roads and Maritime and Gunnedah Shire Council.

The high-level assessment of these options was undertaken with consideration given to the project and supporting objectives in the context of the key constraints within the study area. Following this workshop, three preliminary concept options were shortlisted for further development and assessment as part of this stage of the project.

Step 5 – Development of MCA criteria and weightings

The project objectives provide context for the development of the design and assessment by confirming the issues that are important to Roads and Maritime, key stakeholders and the community.

These objectives form the basis for the development of the main MCA categories used in the assessment. Table 6.1 below outlines these categories and their links to the project objectives.

Table 6.1: MCA categories and link to project objectives

MCA Category	Relevant Project Objective
Engineering	Provide a grade separated HML route through Gunnedah
Traffic, Transport and Safety	Improve local traffic efficiency/transport productivity and reliability Improve road safety
Natural Environment	Minimise the impact on the natural, cultural and built environment
Built / Cultural Environment	Minimise the impact on the natural, cultural and built environment
Value	Provide value for money

The traffic, transport and safety category combines two similar and potentially interrelated project objectives to mitigate the risk for doubling up of criteria within the assessment process.

Similarly, the environmental impacts have been split into two MCA categories to allow appropriate consideration to be given to the significant environmental constraints within the study area and to ensure no criteria are overlooked.

Detailed MCA assessment criteria were established for the five MCA categories identified in table 6.1 using the project's supporting objectives as the basis for this development. A total of 14 MCA criteria were developed for the assessment of the concept options.

The proposed MCA categories, together with supporting criteria, were distributed to the project team, Roads and Maritime and key stakeholders for input and comment. Several responses were received by various parties, all of whom were in general agreement that the categories and assessment criteria reflected the objectives of the project and the key areas of constraint that needed to be considered.

Community and stakeholder values

Following initial agreement being reached on the MCA criteria, the project team reviewed the responses received from the community consultation outlined in section 4 to confirm alignment with the values of the local community members and businesses.

The overwhelming focus of community feedback was in relation to vehicular and pedestrian traffic connectivity and flow as illustrated in figure 4.1. Project cost and environmental concerns also rated as key issues.

The project team therefore concluded that the MCA criteria provided a close correlation with the issues of most importance to the community and stakeholders and were adopted with Roads and Maritime endorsement.

MCA criteria weightings

To ensure that the assessment process remained objective, weightings were applied to each of the MCA criteria prior to doing the detailed assessment of the three concept options.

The following three principles were considered when determining the individual criteria weightings:

- It is important that the purpose of the project does not become forgotten in the assessment weightings
- The individual weightings should reflect a balance between the values and needs of Roads and Maritime, key stakeholders, community members and local businesses
- Criteria in which there is likely to be key and significant differences between the options should be afforded a higher weighting compared with other criteria in which all options perform equally.

Table 6.2 provides a summary of the final agreed MCA criteria and their subsequent weightings to be used as the basis for the assessment of the three concept options.

Table 6.2: MCA criteria and weightings

Assessment Category	Engineering		Traffic, Transport & Safety				Natural Environment			Built / Cultural Environment			Value	
Overall Assessment Weighting	10		30				15			25			20	
MCA Assessment Criteria	Design Performance	Constructability & Staging	Vehicle & Road Safety	Traffic Flow & Connectivity	Pedestrian & Cyclist Access	HML Network Efficiency	Ecology	Flooding & Drainage	Noise & Air Quality	Heritage	Visual Amenity / Urban Design	Community & Business Impacts	Capital Cost	Lifecycle Costs & Benefits
Criteria Weighting per Category (per cent)	60	40	35	30	25	10	50	25	25	15	35	40	65	35
Itemised Weighted Criteria	6	4	10.5	9	7.5	3	7.5	3.75	3.75	3.75	8.75	12.5	13	7

Step 6 – Design development to facilitate assessment process

Detailed investigations have been done to supplement the preliminary desktop studies that were carried out as part of the shortlisting process. These investigations have been used to provide greater accuracy in regard to the constraints which exist for the project.

To allow a complete and accurate assessment, further detailed investigations and design development works have been undertaken. This design development process has been documented in Section 5.

Step 7 – Multi criteria assessment

A detailed assessment has been undertaken for each of the 14 criteria developed and agreed in section 6.1. These assessments have been documented in sections 6.2 to 6.6.

Each assessment has been done independently of the overall MCA to ensure results have not been influenced by their relative weightings and performance against other criteria.

Section 6.7 provides the results of the overall assessment of the three concept options.

6.2 Assessment category: engineering

Design performance

The assessment of design performance considers two fundamental components:

- Quantitative assessment of the way in which each concept option complies with the Roads and Maritime geometric design criteria
- Qualitative assessment of the way in which each proposed alignment functions as intended through moving a design vehicle through the road network.

Minimum Roads and Maritime geometric criteria

Roads and Maritime design guidelines provide strict requirements for developing the geometry of a proposed road, based on significant research and analysis on vehicle and safety performance over many years. Compliance with all design criteria is fundamental to the development of a safe and efficient road network. Acceptance of non-complying designs would typically only be considered in extenuating circumstances.

For the purposes of this assessment, it is assumed that non-compliance does not automatically preclude any option from further consideration. However, should a non-complying option be selected as the recommended option based on its performance against all criteria, a risk assessment must be undertaken at a future stage in the design to attempt to mitigate the consequences of the non-compliance.

The three concept options have been developed using the criteria set out by Roads and Maritime in the project brief, which have been based on the following formal road design guidelines:

- *Austrroads Guide to Road Design* (Roads and Maritime, 2009)
- *Roads and Maritime Supplements to Austrroads Guides* (Roads and Maritime, 2009).

Table 6.3 presents a summary of four of the fundamental design criteria and the performance of each concept option against minimum Roads and Maritime requirements.

Table 6.3: Compliance with Roads and Maritime design criteria

Option	Max Vertical Grade (per cent)	Min Horizontal Radius (metres)	Min Vertical Curve (metres)	Min Sight Distance (metres)
Design Requirement	10	60	Crest 520 Sag 400	48
Option A (single stack)	12.7	145	Crest 570 Sag 400	48.5
Option A (double stack)	12.7	145	Crest 570 Sag 400	48.2
Option B (single stack)	10	85 – 110	Crest 560 Sag 400	50.5
Option B (double stack)	10	85 – 110	Crest 560 Sag 400	50.5
Option C (Refined) (single stack)	10	85 – 105	Crest 520 Sag 400	49.8
Option C (Refined) (double stack)	10	85 – 105	Crest 520 Sag 400	49.8

The vertical grade parameter is the single most significant parameter for this project site and the above table highlights a significant issue with the Option A alignment for single and double stacking clearances.

A vertical grade of 12.7 per cent was required for Option A for the following reasons:

- Alignment followed the existing New Street alignment, which is highly constrained due to the proximity of Barber Street to the north and the Oxley Highway to the south
- A vertical clearance of 4.6 metres for the access from the Mill to Railway Avenue was considered a fundamental requirement to all options based on the Mill's critical need for this access point due to current operations.

The roundabout at the Oxley Highway has to be raised and shifted south resulting in 12.7 per cent grades. This is in excess of the maximum 10 per cent design grades.

The only mitigation available that could reduce this vertical grade would be to raise the ground level at the tie-in points, being the Barber Street intersection and further raising the Oxley Highway. This approach would fundamentally change the broader impacts and has been considered an impractical solution.

Further to this, the Option B and C (Refined) alignments utilise the maximum 10 per cent vertical grade for single and double stacking clearances. It is worth noting that both of these options are flexible enough to use a lower vertical grade if needed. The maximum grade was selected to minimise the footprint of the bridge and create efficiencies in building and reduce overall cost.

Design vehicle movements along alignment

One of the primary considerations in developing road alignments is that the end user receives a product that is fit for purpose. This requirement is subjective and not always easily determined using specific design parameters.

For this project, a fit-for-purpose design is considered one that allows the design vehicles (B-doubles) to easily and efficiently negotiate a path between the Oxley Highway and the Kamilaroi Highway.

Figure 6.2 illustrates the swept path for the three concept options to illustrate the performance of each design.

The Option A alignment again is problematic. Although it provides a direct route into town, the New Street – Barber Street – Warrabungle Street kink is an undesirable alignment for B-double vehicles, whose primary travel path will be between Kamilaroi Highway and the Oxley Highway.

The Option B and C (Refined) alignments, however, provide a continual and smooth path between the locations which is a significantly more desirable outcome for the design vehicle.

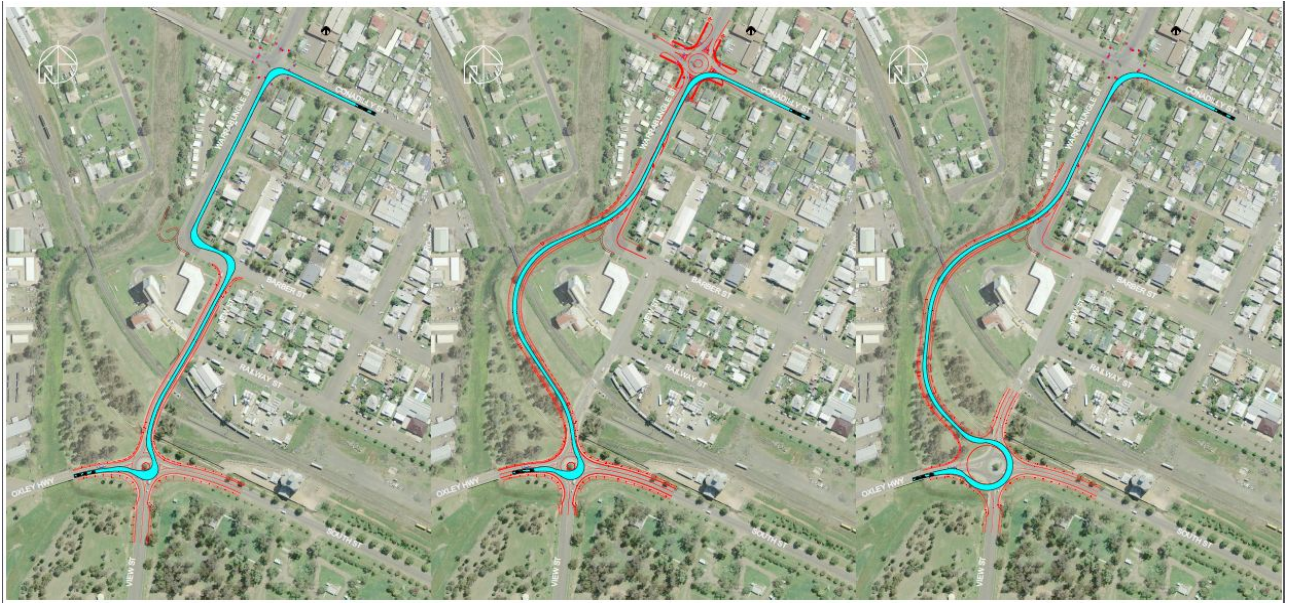


Figure 6.2: Swept path of concept options

Table 6.4 below provides the results of this assessment.

Table 6.4: Summary of design performance assessment

Objective	Score	Option A		Option B		Option C (Refined)	
		Single	Double	Single	Double	Single	Double
Performance of design in relation to minimum and desirable Roads and Maritime geometric criteria	/ 7.5	0.5	0.5	6.5	6.5	6.5	6.5
Ability to manoeuvre the design vehicle along the alignment	/ 2.5	1.0	1.0	2.0	2.0	2.5	2.5
Assessment Score	/ 10	1.5	1.5	8.5	8.5	9.0	9.0
Assessment Score	/ 100	15	15	85	85	90	90
Weighted Score	/ 6	0.9	0.9	5.1	5.1	5.4	5.4

Constructability and staging

The outcome of the comparative analysis of the constructability impacts is shown in table 6.5 below. The assessment is based on the outcomes of the constructability workshop held on 10 September 2013.

Table 6.5: Summary of constructability assessment

Objective	Score	Option A		Option B		Option C (Refined)	
		Single	Double	Single	Double	Single	Double
Flooding and Drainage	/ 10	4	3	6	6	5	5
Geotechnical	/ 10	3	3	6	6	5	5
Utilities	/ 10	6	5	7	7	5	5
Structure	/ 10	2	2	4	4	6	6
Staging	/ 10	1	1	4	4	7	7
Safety	/ 10	2	1	5	5	6	6
Properties	/ 10	3	3	4	4	4	4
Environmental	/ 10	4	3	5	5	6	6
Traffic	/ 10	4	3	6	6	5	5
Other	/ 10	3	2	6	6	6	6
Assessment Score	/ 100	32	26	53	53	55	55
Weighted Score	/ 4	1.3	1.0	2.1	2.1	2.2	2.2

Key issues which are considered differentiators for the assessment are summarised in table 6.6.

Table 6.6: Key constructability issues

Assessment Category	Key constructability factors requiring mitigation during construction
Flooding and Drainage	A: Culverts extensions clean water diversions and staging C (Refined): Impacts of working within the creek
Geotechnical	A: RSW walls on top of culvert A: Piling adjacent to Mill and residential buildings B & C (Refined): Northern wall foundations on soft soils, slightly longer for C (Refined)
Utilities	C (Refined)& B: Major water main proximity affect worse on C (Refined) A: Power poles and streetlights worst affect B & C (Refined): Power poles and streetlights minor effect on B
Structure	A: Piling within potentially contaminated ground A: Extremely narrow New St corridor for delivery and erection of precast beams B: High skew angle over ARTC corridor restrictions
Staging	A: Potentially contaminated ground may require remediation before starting A: Raising of roundabout and level crossing closure consequences include staging for B Doubles A: Require continuous access to the Mill A: Potential span by span construction due to narrow corridor B: Requires closure of the level crossing
Safety	A: Pedestrian access restrictions A: Site security concerns within a works area more exposed to the public A: Very constrained work site
Properties	A: RSW walls construction directly outside residential properties A: Noise impacts worst impact A: Restricted access to residences and Railway Street B & C (Refined): Restricted access along the Mill acquisition area and Warrabungle Street and Barber Street
Environmental	A: Potentially contaminated fuel depot and old rail yard areas A: Clean water flows during raising of the roundabout A: Restricted access to residences and Railway Street B & C (Refined): Impacts on trees within Blackjack Creek and potential koala measures required
Traffic	A: Traffic flow and bus routes changes A: Worst temporary works staging with consequent user delays and increased travel times B & C (Refined): Revised traffic arrangements on Warrabungle Street C (Refined): Requires roundabout works staging, without raising
Other	A: Level crossing closure divides the site into separated areas A: Worst temporary works staging with consequent community and passing tourists

Assessment Category	Key constructability factors requiring mitigation during construction
	impacts over an extended construction period B & C (Refined): Construction in close proximity to caravan park

6.3 Assessment category: traffic / transport / safety

Vehicles and road safety

As part of the desktop and site investigation works undertaken, a review of major road safety issues was undertaken by GTA Consultants to facilitate the selection of a safe design solution for all road users, including pedestrians, cyclists and motorists.

Road safety issues were identified for each option, characterised by four key considerations:

- Vehicle priority
- Sight lines
- Conflicts with local access
- Pedestrian and cyclist safety considerations.

An assessment of road safety risk has been done based on adapted version of the standard Austroads Risk Matrix. The following road safety risks have been identified for each option.

Option A - road safety review

The following safety risks have been identified for the Option A configuration:

- The footpath is located along the east side of the road only, with no crossing facilities provided at the intersections, which could increase the number of pedestrians walking on the road instead of the footpath provided
- No linking footpaths are provided on Oxley Highway, View Street and Barber Street meaning pedestrians may walk on the road to link to the existing paths in the vicinity
- Potential for queuing at the intersections and that drivers are unable to see the back of the queue as a result of the steep down grade road
- Turn around facility is required at the western end of Railway Street to avoid vehicles colliding at this dead end
- Potential restricted sight lines to vehicles travelling in Warrabungle Street/Barber Street where fencing or barriers are used.
- There are safety issues associated with the 12.7 per cent vertical grade of the bridge connecting with a T-junction at Barber Street and the resulting potential for down grade

speeds to be higher, as well as in regard to restriction of sight lines

- It is unclear who has priority at the intersection of Barber Street and the bridge. Line marking and appropriate signage will be required
- There may be vertical restrictions to the appropriate achievable sight lines at the roundabout.

Option B - road safety review

The following safety risks have been identified for the Option B configuration:

- Level crossing is to be maintained for pedestrian and cyclist use, such that existing safety risks will remain. However, pedestrians are more likely to walk on the road, now that there are no vehicles, in which case they may walk in front of a train
- No linking footpaths are provided on Oxley Highway, View Street and Barber Street, meaning pedestrians may walk on the road to link to the existing paths in the vicinity
- The bridge has a reasonable curve. Due to the narrow bridge width there is potential for insufficient sight lines at these curves
- The footpath is located along the east side of the bridge only. Safe crossing facilities should be provided at the intersections in consideration of existing pedestrian desire lines. This could increase the number of pedestrians walking on the road instead of the footpath provided
- The left turn lane in Warrabungle Street could confuse drivers, given it is not located at an intersection. Collisions at the southbound entry to the bridge may occur
- No details of end treatments have been designed at this stage. Vehicles could collide with the bridge/barrier end treatments at the entry from Warrabungle Street
- It is unclear how westbound Barber Street traffic would be managed. This could create ambiguity and vehicles attempting to turn around could collide with southbound traffic in Warrabungle Street heading towards Barber Street
- There are driveways to properties in the vicinity of the northern bridge abutment/ramp on Warrabungle Street. As such, collisions are possible when vehicles attempt to enter driveways
- There may be vertical restrictions to the appropriate achievable sight lines at the roundabout.

Option C (Refined) - road safety review

The following safety risks have been identified for the Option C (Refined) configuration:

- If the level crossing is to be maintained, all existing safety risks will still exist
- If no linking footpaths are provided on Oxley Highway, View Street and South Street, pedestrians may walk on the road to link to the existing paths in the vicinity
- In the event that vehicles have to wait at the crossing for large trains, vehicles may attempt to turn around and use the bridge instead and potentially collide with other vehicles, barriers or the train.
- The footpath is located along the east side of the bridge. Safe crossing facilities should be provided at the intersections in consideration of existing pedestrian desire lines.
- The left turn lane in Warrabungle Street could confuse drivers, given it is not located at an intersection. Collisions at the southbound entry to the bridge may occur. Note this does not apply with Barber Street inclusion – see section 8.4
- No details of end treatments have been designed at this stage. Vehicles could collide with the bridge/barrier end treatments at the entry from Warrabungle Street
- It is unclear how westbound Barber Street traffic would be managed. This could create ambiguity and vehicles attempting to turn around could collide with southbound traffic in Warrabungle Street heading towards Barber Street. Note this does not apply with Barber Street inclusion – see section 8.4
- There are driveways to properties in the vicinity of the northern bridge abutment/ramp on Warrabungle Street. As such, collisions are possible when vehicles attempt to enter driveways
- Maintaining access to New Street from the roundabout would increase the number of trucks using residential streets to access the Kamilaroi Highway, given the road closure in Warrabungle Street
- There may be vertical restrictions to the appropriate achievable sight lines at the roundabout.

Vehicle priority

Each concept option has been assessed in terms of the legibility of vehicle priority over all movements within the study area. For this criteria, single and double stacking impacts are equivalent.

For Option A, vehicle movements essentially replicate the current situation. The key location is the T-intersection at the north end of the bridge at Barber Street, which would need to be more clearly defined.

For Options B and Option C (Refined), vehicle priority issues that currently exist at the New Street/Barber Street intersection would be improved due to the low volumes of traffic that would be experienced. However, these issues are essentially transferred toward the Warrabungle Street / Kamilaroi Highway give way intersection.

Due to the results of the design development process necessitating that this intersection be immediately upgraded to a roundabout for Option B, a significant positive impact would be observed at this intersection from a vehicle priority perspective.

Sight lines

This indicator considers the safety risks associated with the sight lines for the road and the vehicles using it and are most influenced by the horizontal and vertical alignments of each concept option.

In Option A, the steep gradient and constrained path limit the provision of safe sight lines. This issue becomes more significant with the double stacking configuration.

The longer bridge lengths of Options B and Option C (Refined) provide the opportunity for these issues to be addressed.

Conflicts with local access

This indicator considers the potential safety risks relating to conflicts with local property access points.

For Option A, because the alignment closely matches the current configuration, conflicts with access points will remain essentially unchanged.

For Options B and Option C (Refined), however, additional conflict points are introduced along Warrabungle Street north of Barber Street, including the entry into the existing caravan park.

Pedestrian and cyclist safety

This indicator compares the way in which each option provides a convenient and safe path for pedestrians and cyclists to cross the railway line.

In Option A, the level crossing would be closed, and the only pedestrian or cyclist option to cross the railway in this location would be on the bridge itself. This is problematic as the bridge has grades in excess of 12 per cent whilst the desirable maximum grade for cyclists is five per cent.

In options B and option C (Refined), the bridge path has a 10 per cent grade. However, the option of utilising the existing level crossing for pedestrians and cyclists (subject to approval by ARTC) has been considered.

Based on the assessment outlined above, table 6.7 provides an assessment of the performance of each option relative the four key indicators previously identified

Table 6.7: Summary of vehicle and road safety assessment

Objective	Score	Option A		Option B		Option C (Refined)	
		Single	Double	Single	Double	Single	Double
Vehicle priority	/ 5	3	3	5	5	4	4
Sight lines	/ 5	2	1	3	2	3	2
Conflicts with local access	/ 5	3	3	2	2	2	2
Pedestrian / cyclist safety	/ 5	1	1	2	2	2	1
Assessment Score	/ 20	9	8	12	10	11	9
Assessment Score	/ 100	45	40	60	50	55	45
Weighted Score	/ 10.5	4.7	4.2	6.3	5.3	5.8	4.7

Traffic flow and connectivity

The traffic flow and connectivity assessment considers the way each option contributes to a higher level of road network connectivity, bringing about potential improvements in traffic flows through improved levels of service and lower average delays.

The assessment has been informed by the development of several Sidra Intersection software models that have been prepared to assess traffic flow and connectivity advantages and disadvantages for each preliminary option.

SIDRA Intersection modelling results

Base case and future year models were prepared using peak traffic flow assumptions and supplemented by traffic counts undertaken in March 2013 for the following intersections:

- New Street / View Street / Oxley Highway / South Street intersection
- Kamilaroi Highway/Warrabungle Street intersection.

Table 6.8 below presents these modelling results.

Table 6.8: SIDRA traffic modelling results

Year	Option A		Option B		Option C (Refined)	
	Vehicle Delay	Service Level	Vehicle Delay	Service Level	Vehicle Delay	Service Level
New Street / View Street / Oxley Highway / South Street Intersection						
2013	11	A	11	A	11	A
2016	12	A	12	A	14	A
2026	13	A	13	A	14	A
2036	19	B	19	B	20	B
Kamilaroi Highway / Warrabungle Street Intersection						
2013	14	A	14	A	14	A
2016	17	B	391 (11)	F (A)	17	B
2026	60 (11)	E (A)	(12)	(A)	60 (11)	E (A)
2036	(12)	(A)	(14)	(A)	(12)	(A)

The figures presented in brackets for the Kamilaroi Highway / Warrabungle Street intersection represent the traffic efficiency results for the intersection based on a suitable intersection treatment being constructed to improve traffic flow. For this assessment, the assumption has been made that the existing 'Give Way' intersection will be replaced by a roundabout.

The assessment of traffic connectivity and flow has been made on the basis that the required intersection treatments are done at a time when the performance of the road network drops below an acceptable level.

Legibility of road hierarchy

This indicator considers the way in which each concept option contributes to the resulting road hierarchy within the study area.

Option A would likely result in higher traffic volumes travelling through the existing road network structure, which would result in negative impacts on legibility, particularly at the New Street / Barber Street intersection.

Option B and Option C (Refined) eliminate this issue by having the majority of traffic flow onto Warrabungle Street. Option B, by upgrading the Conadilly Street / Warrabungle / Kamilaroi Highway intersection to a roundabout, contributes positively to the legibility of the road network structure and traffic flows.

Intersection performance

The assessment of intersection performance has been based on the traffic modelling outlined above. It considers the level of service provided by each concept option, together with the average vehicle delays.

Options A and B perform at the same level and better in comparison with Option C (Refined) at the Oxley Highway / New Street intersection. Option A and Option C (Refined) perform at the same level and better than Option B at the Warrabungle Street / Kamilaroi Highway intersection.

Network performance

Each concept option was assessed against the likely performance of the road network in Gunnedah, characterised by how the potential changes in traffic movements in the town centre would be affected by redistributed traffic.

Option A links the bridge with local roads in a manner that is likely to redistribute traffic through Barber Street and adjacent intersections, with some of these local roads unlikely to be able to cope with the increased traffic volumes.

Options B and C (Refined) are less likely to redistribute traffic through traffic onto the local road network and intersections, due to their alignments running west of the Mill directly onto Warrabungle Street.

Road connectivity

Each option was assessed in relation to its connectivity with the highway network and local road network.

It is worth noting that these two factors address potentially conflicting objectives and therefore concept options displaying flexibility in balancing the highway and local road issues will result in a more positive assessment result overall.

Option B provides the most efficient connection with the highway network, providing the most direct route between the Oxley Highway and Kamilaroi Highway, although it is only marginally more direct than Option C (Refined). Option A is a direct but less efficient alignment that has a considerable kink in it between New Street / Barber Street / Warrabungle Street.

The assessment results have been summarised in the Table 6.9.

Table 6.9: Summary of traffic flow and connectivity assessment

Objective	Score	Option A		Option B		Option C (Refined)	
		Single	Double	Single	Double	Single	Double
Legibility of road hierarchy	/ 5	2	2	5	5	4	4
Intersection performance	/ 5	4	4	4	4	3	3
Network performance	/ 5	3	3	4	4	5	5
Connectivity with highway network	/ 5	3	3	5	5	5	5
Connectivity with local network	/ 5	4	4	2	2	4	4
Assessment Score	/ 25	16	16	20	20	21	21
Assessment Score	/ 100	64	64	80	80	84	84
Weighted Score	/ 9	5.8	5.8	7.2	7.2	7.6	7.6

Pedestrian and cyclist access

Pedestrian and cyclist access considers the extent to which each option facilitates the movement of pedestrians and cyclists safely and efficiently in line with desire lines while considering future planned infrastructure for the town.

Pedestrian movements and volumes

Traffic counts undertaken in March 2013 suggest that the existing New Street level crossing is the third busiest level crossing in Gunnedah. Actual volumes of pedestrian traffic are relatively small in comparison to other modes of transport, however, the presence of 'goat tracks' in the vicinity of the level crossing suggest that there may be higher pedestrian demand outside of typical peak periods, such as for weekend sport or recreational trips.

Cyclist network

The Gunnedah Strategic Plan outlines a vision for a shared cycleway network that is partially complete and will ultimately connect the residential areas south of the railway line, the Gunnedah town centre north of the railway line and the Namoi River.

Assessment

The proposed configuration of the pedestrian and cyclist network for each shortlisted option has been illustrated in figure 6.3. Note that these proposals assumed that the level crossing could remain open to pedestrians and cyclists

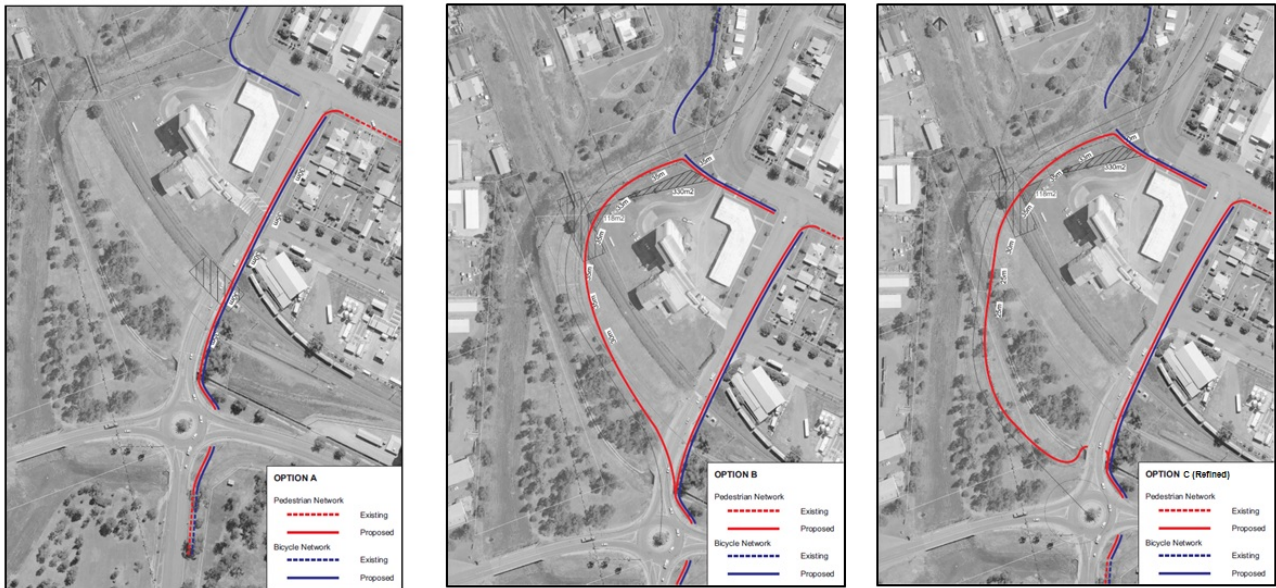


Figure 6.3: Pedestrian and cyclist network for each shortlisted option

In Option A, the pedestrian and cyclist path would be on the proposed bridge along New Street. As such the level crossing would be completely closed and path users would need to negotiate the 12.5 per cent grade on each side of the railway crossing.

In Option B, a shared path would be provided on the east side of the bridge to cater to pedestrian desire lines. This path would link the east side to View Street south of the Oxley Highway / New Street roundabout and onto Barber Street at the northern end of the bridge.

In addition to the path provided on the bridge, an alternative pedestrian and cyclist path may be provided on New Street (subject to ARTC approval) through the existing level crossing, which would be kept open for pedestrians and cyclists only. This would provide a more direct route to the centre of town, which is consistent with the desire lines.

In Option C (Refined), a shared path would be provided on the east side of the bridge connecting Oxley Highway / View Street roundabout with Warrabungle Street at the northern end of the bridge. In addition to the path provided on the bridge, an alternative pedestrian and cyclist path may be provided on New Street (subject to ARTC approval) through the existing level crossing, which would be kept open for pedestrians and cyclists only.

Note: In 2014, ARTC has advised of an upgrade of the Marquis Street level crossing for vehicles, pedestrians and cyclists and that the New Street level crossing would be closed to all traffic. An updated pedestrian and cyclists strategy is described in section 9.

The assessment results have been summarised in the Table 6.10.

Table 6.10: Summary of pedestrian and cyclist access assessment

Objective	Score	Option A		Option B		Option C (Refined)	
		Single	Double	Single	Double	Single	Double
Capacity of bridge path	/ 5	2	2	2	2	2	2
Directness of bridge path	/ 5	4	3	2	1	1	1
Connectivity with existing routes	/ 5	2	2	4	4	4	4
Provision of alternative opportunities	/ 5	2	1	4	4	4	4
Assessment Score	/ 20	10	8	12	11	11	11
Assessment Score	/ 100	50	40	60	55	55	55
Weighted Score	/ 7.5	3.8	3.0	4.5	4.1	4.1	4.1

HML network efficiency

The assessment of HML efficiency considers the way in which each option addresses the key objective for this project, which is to facilitate HML access through Gunnedah.

Two primary indicators have been used to compare each of the shortlisted options:

- How directly would heavy vehicle traffic be linked from one side of Gunnedah to the other
- How accessible is the HML route for those freight vehicles travelling from, to or through Gunnedah, i.e. how efficient would the interface be between the local road network and the HML network for heavy vehicles in Gunnedah.

HML route connectivity

Options B and C (Refined) provide a direct and smooth alignment west of the Mill that will perform well in facilitating the uninterrupted HML network through Gunnedah. However, Option A maintains the existing route through the local streets that has a considerable kink in the alignment, which is an undesirable feature of this route.

HML route accessibility

This indicator considers how the resulting HML route for each concept option would be accessible for freight vehicles from warehouses and terminals within Gunnedah itself.

Based on these two indicators, each concept option was evaluated in terms of how each contributes towards a more efficient HML network. Table 6.11 provides a summary of these results.

Roads and Maritime and Council are currently reviewing future road classification in Gunnedah to enable HML route to become operational. The reviewed classifications of the Oxley and Kamilaroi Highways in Gunnedah are agreed and the process has commenced to formalise the arrangements. Refer to section 11 for further details.

Table 6.11: Summary of HML network efficiency assessment

Objective	Score	Option A		Option B		Option C (Refined)	
		Single	Double	Single	Double	Single	Double
HML route connectivity	/ 5	2	2	5	5	5	5
HML route accessibility	/ 5	3	3	2	2	4	4
Assessment Score	/ 10	5	5	7	7	9	9
Assessment Score	/ 100	50	50	70	70	90	90
Weighted Score	/ 3	1.5	1.5	2.1	2.1	2.7	2.7

6.4 Assessment category: natural environment

Ecology

Context and approach

This ecological assessment considers and compares each option against 18 parameters that are consistent with the federally accepted framework for Commonwealth offsetting. This provides a transparent means of comparing the overall ecological impact across a broad range of categories with different levels of relevance, with each parameter weighted accordingly.

In general, the study area has been extensively modified through vegetation clearing and drainage works for urban purposes and has been disturbed from its natural state by weed encroachment, replanting and development. However, several ecologically sensitive areas remain within the study area. These include:

- Koala habitat comprising of Secondary Feed Tree species, is located in the study area. Preliminary investigations into the general koala population indicate that the habitat in the study area is potentially 'critical to the survival of the listed species'. This will be reviewed during the environmental impact assessment
- Blackjack Creek, a highly modified ephemeral creek with intermittent flows from urban stormwater, traverses the study area
- The native vegetation surrounding Blackjack Creek in the study area forms a Regional Biodiversity Link (Wildlife connectivity corridor)

- This link also forms a component of an aquatic Endangered Ecological Community (EEC), the '*Lowland Darling River aquatic ecological community*', which is highly modified, predominately dry and 'unlikely fish habitat'
- State-listed EEC, the '*White Box – Yellow Box – Blakely's Red Gum*', is located within the study area is classified as being in 'low condition'.

Koala habitat

The Namoi River to the north of the study area provides an important drought refuge for the species and forms part of a primary koala habitat. Secondary koala habitats containing other food and resting sources are located to the south and southwest of the river.

In general, koalas have a preference to move along drainage lines and within vegetation areas, making the study area a pathway between primary and higher quality secondary habitats. Old growth trees in the Gunnedah Showground, along View Street and generally south of the railway line within the study area, provide suitable resting and foraging habitat. This vegetation is important as it provides places for rest and temporary feeding.

Evidence reviewed regarding the study area indicates that it is within the home range of a background population of at least two individuals. Single night spotting undertaken on two occasions (October 2012 and May 2013) observed one koala on each occasion. One of these koalas was located south of the Oxley Highway within the study area. Koala scats were also found within the native vegetation in the project site study area as show in figures 6.4 to 6.6.

Therefore, three koala habitat attributes located within the study area need to be considered when comparing each shortlisted option:

- The species located within the study area forms part of an 'important population' in accordance with the definition provided in the NSW Recovery Plan.
- The study area forms part of a regional biodiversity link (daily, seasonal and drought refuge movements)
- The study area contains secondary food tree species (feeding and resting resources).

Blackjack Creek / Regional Biodiversity Link

Blackjack Creek is a highly modified and degraded waterway that is usually dry and mowed. No groundwater-dependant ecosystems have been identified within the study area.

The creek is inclusive of a 30 metre buffer that constitutes a Regional Biodiversity Link which connects to the Namoi River, a State Biodiversity Link, and forms a component of the Lower Darling aquatic EEC.

The study area provides movement for koalas utilising this Regional Biodiversity Link connecting Secondary Class 2A Koala Habitat (as defined in the Gunnedah Koala Plan of Management), 500 metres to the south, to Primary Koala Habitat, 660 metres to the north along Blackjack Creek.

Wildlife movement in utilising these links in the study area is affected by existing built infrastructure from the south of the Oxley Highway to the Namoi River. Access pinch points within the study area include the rail culvert over the creek and to a lesser extent the level crossing on New Street. These points along with the major roads in the study area and the rail reduce the effectiveness of the link.

Terrestrial Endangered Ecological Community (EEC)

Five patches of the State-listed EEC *Yellow Box - Blakely's Red Gum grassy woodland of the Nandewar Bioregion* are located within the centre of the study area (refer to Figures 6.4 to 6.6 below). The remnants are divided by minor drainage paths and New Street to the east. The vegetation also forms suitable feeding habitat for the koala as discussed earlier in this section.

Potential impacts

The key residual potential ecological impacts of the assessment options are presented below. A number of other ecological issues (such as Potential Injury and Fatality of Koalas) identified relating to the assessments.

Option A does not directly encroach on any native vegetation as indicated in figure 6.4. All vegetation present in the Option A study area is 'open mowed areas or infrastructure'. No habitats would be fragmented and there would be no significant impediments to Wildlife connectivity as a result of Option A. No potential aquatic impacts are anticipated on the Option A alignment.

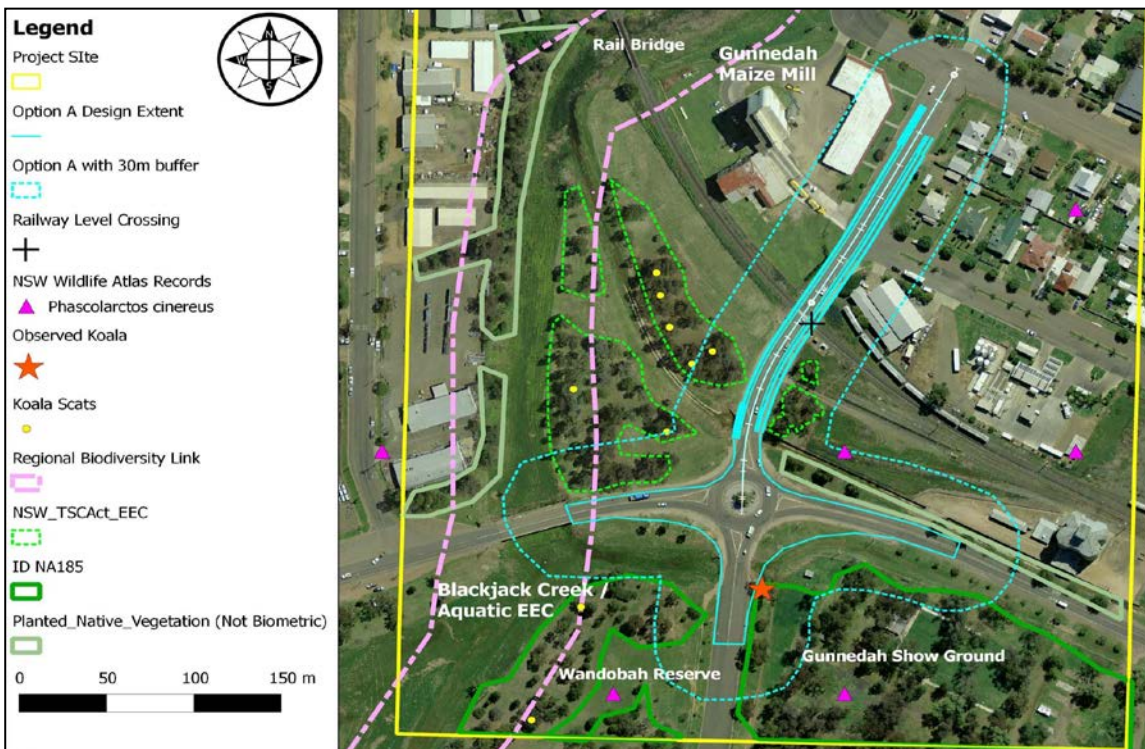


Figure 6.4: Option A ecology impacts

Option B alignment and study area shown in figure 6.5 impacts upon native vegetation of the NSW EEC *Yellow Box - Blakely's Red Gum grassy woodland* and would require 0.2 hectares to be cleared. Therefore, potential operational effects will see a permanent loss of 0.2 hectares of koala feeding habitat and potentially discourage the migration of koalas through this area. Detailed tree surveys are proposed to further determine the significance of the vegetation.

Habitat fragmentation would not occur during operation, but potential building impacts would remove about 50 per cent of a 0.3 hectares planted native vegetation area within the mapped design detail footprint.

Potential construction impacts would potentially directly affect 165 metres of the mapped extent of the Regional Biodiversity Link, which represents a potential reduction in its 'refuge' habitat role in wildlife connectivity. The construction area would not block the access point, but would reduce its mapped width from about 75 metres to 30 metres at its narrowest point, during building daily, seasonal or drought refuge migratory behaviour may be affected if works are within the Regional Biodiversity Link. It is unlikely that this would be the case during operation.

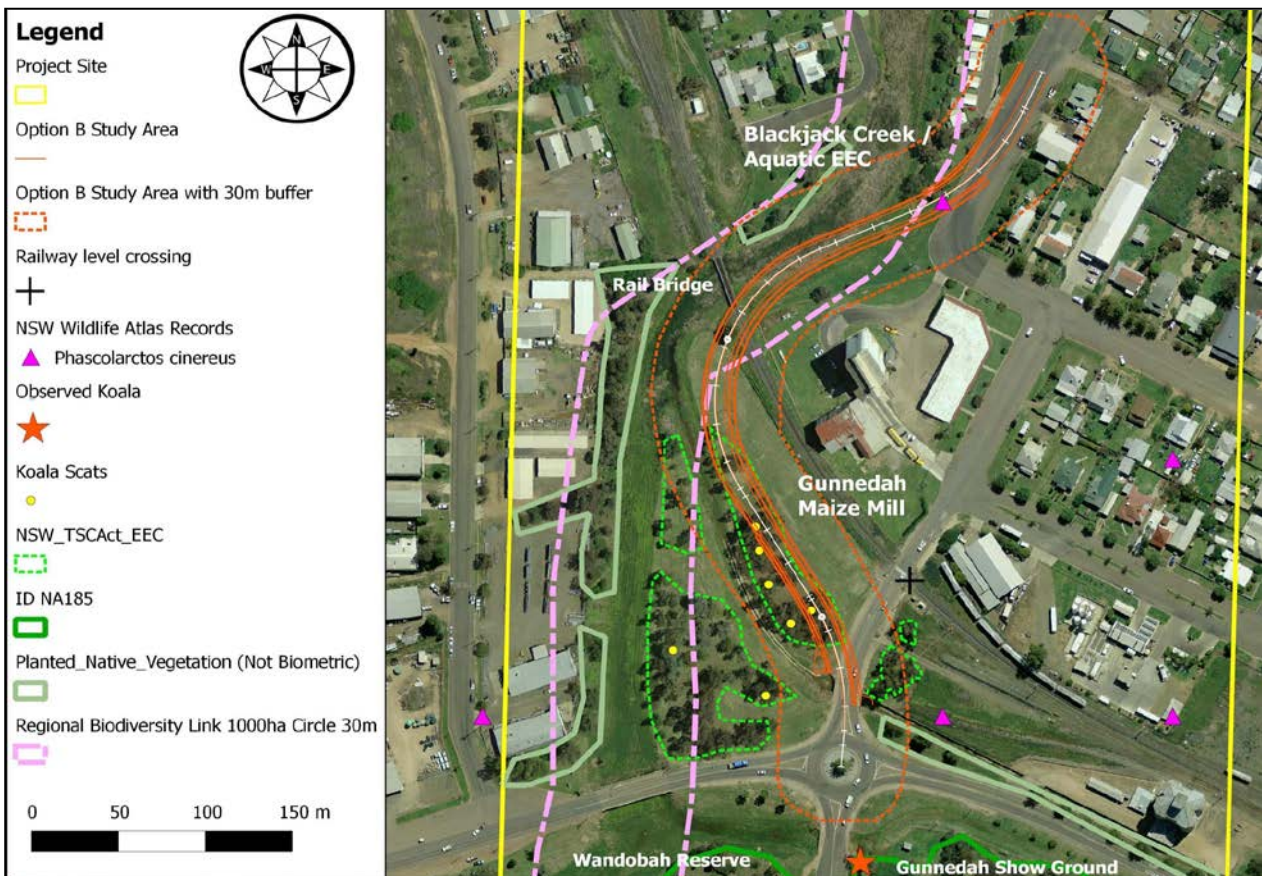


Figure 6.5: Option B ecology impacts

Option C (Refined) alignment and study area shown in figure 6.6 impacts upon native vegetation of the NSW EEC Yellow Box - Blakely's Red Gum grassy woodland and would require 0.25 hectares to be cleared. Therefore, potential operational effects will see a permanent loss of 0.25 hectares of koala feeding habitat.

Habitat fragmentation will potentially occur by completely removing a small area of planted vegetation and isolating two larger planted areas either side of the proposed road alignment.

Potential construction impacts would potentially directly affect 313 metres of the mapped extent of the Regional Biodiversity Link, which represents a potential reduction in its 'refuge' habitat role in wildlife connectivity. The construction area would not block the access point but reduce its mapped width from approximately 75 metres to 30 metres at its narrowest point. During building daily, seasonal or drought refuge migratory behaviour may be affected if works are within the Regional Biodiversity Link. These impacts will be reviewed during the environmental impact assessment.

During operation, koala movement would not be impeded from one side to the other under the new viaduct structure and it is unlikely that it will have a significant potential effect to daily, seasonal or drought refuge migrations.

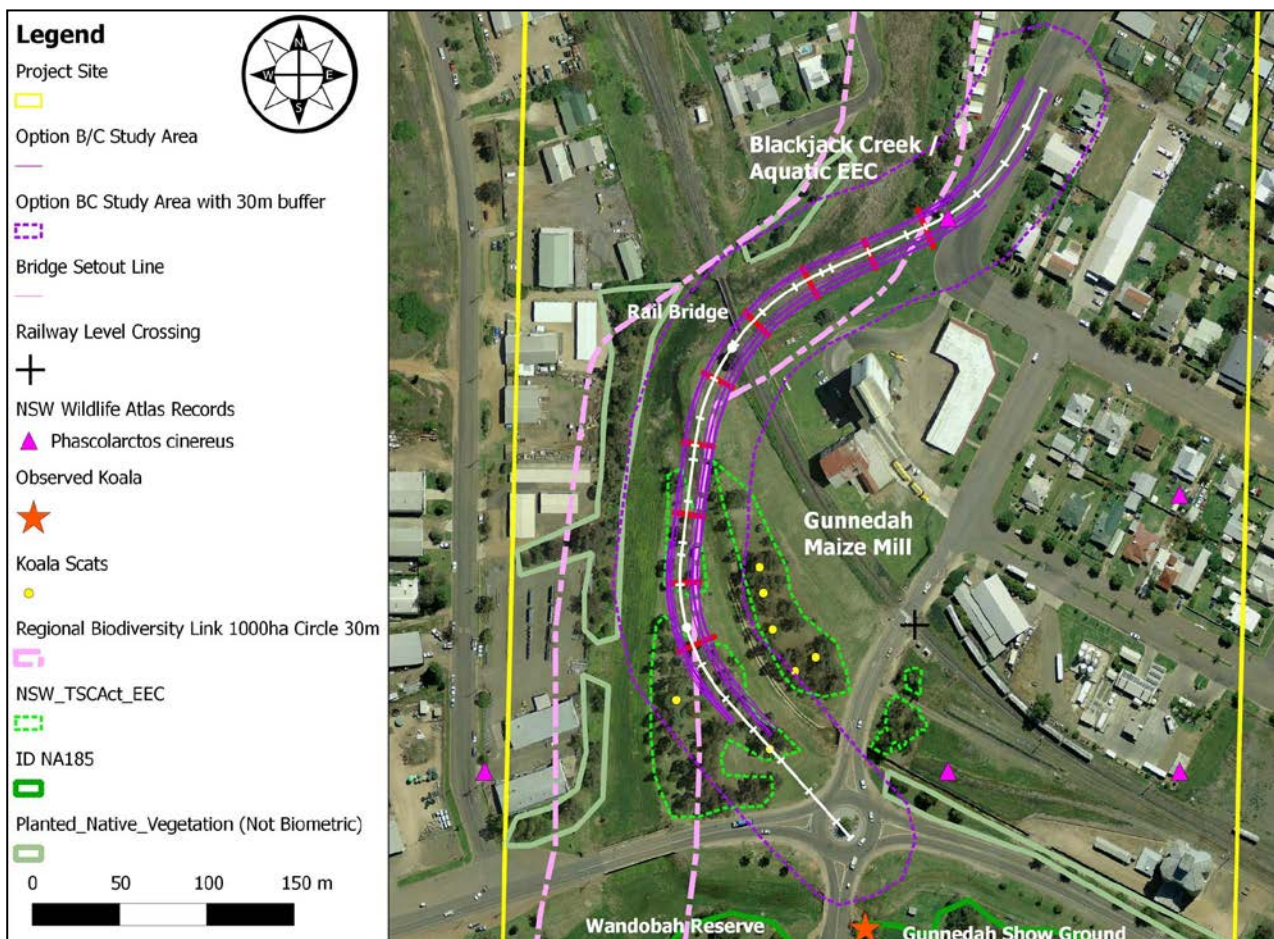


Figure 6.6: Option C (Refined) ecology impacts

Feasibility of mitigation

Three options have been assessed. Option A has avoided substantive native vegetation. Option B and C (Refined) will potentially effect planted native vegetation that is a secondary Food Tree Species for a known important koala population and a NSW EEC and a Regional Biodiversity Link / Aquatic EEC.

A positive potential residual impact is that the new structure is also likely to create new habitat for listed cave / structure dependant microbats.

In general, Options A, B or C (Refined) will not clear more than one hectare of native vegetation or result in the extinction of koalas and therefore would not require offsets following *Roads and Maritime Guidelines for Biodiversity Offsets November 2011*. Mitigation measures for ensuring the protection of koalas during construction and operation. For example, koala habitat which is cleared can be replaced by using a mixture of Primary and Secondary Food Tree Species (all quick growing) elsewhere in the Regional Biodiversity Link.

Future assessments required include assessments of significance and seven-part tests of significance of all federally and state-listed EECs and threatened species would be required during the impact assessment phase.

Assessment

The comparative analysis of options determined that Option A presented the best option for meeting ecological objectives (97.4/100 average score over construction and operation) as it avoided vegetation clearance almost entirely. Option B and C (Refined) scored very similar (74.9/100, 73.4/100 respective average scores) as the residual effect of impacts only differed by a small amount of area to be cleared.

The effect of the Double Stack option did influence the assessment of options. All options scoring equally to the single equivalent, as outlined in table 6.12 below.

Table 6.12: Summary of ecology assessment

Objective	Score	Option A		Option B		Option C (Refined)	
		Single	Double	Single	Double	Single	Double
Loss of Vegetation / Habitat	/ 6.8	6.8	6.8	5.1	5.1	5.1	5.1
Threatened Species Issues	/ 6.8	6.8	6.8	6.4	6.4	6.4	6.4
Endangered Ecological Community Issues	/ 6.8	6.8	6.8	4.5	4.5	4.5	4.5
Over-cleared Vegetation Issues	/ 6.8	6.8	6.8	5.4	5.4	5.4	5.4
Probability of Species Impact Statement	/ 6.8	6.8	6.8	4	4	4	4
Probability of Commonwealth Referral	/ 6.8	6.8	6.8	4	4	4	4
Wildlife Connectivity	/ 6.8	6.8	6.8	4	4	2.5	2.5
Injury and Mortality	/ 6.8	6.8	6.8	6	6	6	6
Weeds	/ 4	4	4	4	4	4	4
Pests and Pathogens	/ 4	4	4	4	4	4	4
Changed Hydrology	/ 4	4	4	2	2	2	2
Groundwater Dependent Ecosystems	/ 4	4	4	4	4	4	4
Aquatic Impacts	/ 4	4	4	3	3	3	3
Noise, Vibration and Light	/ 4	4	4	4	4	4	4
Key Threatening Processes	/ 4	4	4	3	3	3	3
Cumulative Impacts	/ 6.8	5	5	4	4	4	4
Koala Habitat	/ 6.8	6	6	3.5	3.5	3.5	3.5
Other Sensitive Ecological Sites	/ 4	4	4	4	4	4	4
Assessment Score	/ 100	97.4	97.4	74.9	74.9	73.4	73.4
Weighted Score	/ 7.5	7.3	7.3	5.6	5.6	5.5	5.5

Flooding and drainage

Blackjack Creek drains runoff from a catchment area of approximately 24 square kilometres to the Oxley Highway over a length of 8 kilometres between the upper reach catchment boundary to the cross drainage structures at the Oxley Highway. The creek then discharges to the floodplain of the

Namoi River, which is a significant floodplain impacting Gunnedah and directly impacting the study area.

The assessment of flooding impacts considers the performance of each option against the following criteria:

- Afflux in Blackjack Creek as a result of construction of each option
- Indirect impact on minor reaches of the catchment
- Potential for scour and erosion.

Flood modelling

To quantify the impacts each option has on the existing flood conditions, a flood modelling exercise was undertaken on Blackjack Creek.

A HECRAS model was generated for the entire length of Blackjack Creek to a point about 70metres downstream of the Kamilaroi Highway crossing. Cross sections were developed to simulate each concept option. Table 6.13 presents the results of this exercise for 100 year ARI.

Table 6.13: Flood modelling results

Option	Afflux (millimetres)	Flow velocity (metres)
Option A (single and double stacking)	0	N/A
Option B (single and double stacking)	6	0.53
Option C (Refined) (single and double stacking)	11	0.53

NOTE: The above assessment is based on initial design information and has been revised (See section 9.3)

Afflux

The afflux defines the rise in water level that is observed due to the building of each concept option. To assess the impacts of afflux on Blackjack Creek, the results need to be considered in context.

For this project, considering large areas of Gunnedah are already flood prone in the vicinity of the study area, an afflux of 50 millimetres has been considered a reasonable maximum value to accept prior to having to significant modify the alignment or construction technique.

Option A, being geographically removed from the Blackjack Creek floodplain, does not contribute any impact to flooding.

Options B and C (Refined) produce afflux values less than 20 millimetres. This is due in part to the viaduct approach with long spans between piers, so that the extent of obstruction in and adjacent

to the creeks is minimised. These values could be considered as a very minor impact, although more detailed modelling would be recommended should one of these options be adopted as the preferred option.

For the assessment process, each option is scored on a linear scale based on the afflux observed. An afflux of 0 represents a 100 per cent score, where the adopted maximum allowable afflux of 50 millimetres would represent a 0 per cent score.

Impacts on minor reaches

The minor reaches most directly impacted by this option include the following:

- Existing open channel drain located between the Oxley Highway and railway line which discharges directly into Blackjack Creek. An existing culvert under New Street presents a potential pinch point for this reach
- Existing open channel drain located on the south side of the Oxley Highway and South Street which discharges directly into Blackjack Creek. An existing culvert under View Street south of the existing roundabout presents a potential pinch point for this reach.

Each concept option will have some potential impact on both of these reaches as the existing roundabout at the Oxley Highway is proposed for upgrade in all cases.

Options A and B will impact both culverts more significantly than Option C (Refined), which swings wide of the northern reach until it crosses its path as a viaduct.

The double stacking alignment of Option A creates the most significant impact, as the existing roundabout will be raised and shifted with significant earthworks being required. Retaining walls may be necessary to prevent this option encroaching on these existing channels.

Potential for scour and erosion

The potential for scour is considered primarily within the confines of the main channel of Blackjack Creek. More detailed investigation would be required to accurately assess the overbanks.

Option A will have no impact on Blackjack Creek, but the additional earthworks and potential encroachment into the minor reaches outlined above, mean that scour will need to be considered in these locations.

Options B and C (Refined) create obstructions within the floodplain of Blackjack Creek. With flow velocities of less than two metres scour is unlikely, although mitigation measures would still be recommended. The Option C (Refined) alignment has a slightly greater impact due to its proximity close to the creek for a longer length.

Table 6.14 summarises the assessment results.

Table 6.14: Summary of flooding and drainage assessment

Objective	Score	Option A		Option B		Option C (Refined)	
		Single	Double	Single	Double	Single	Double
Afflux in Blackjack Creek	/ 15	15.0	15.0	13.2	13.2	11.7	11.7
Impact on minor reaches	/ 5	3.5	3.0	3.5	3.5	4.0	4.0
Potential for scour and erosion	/ 5	4.5	4.0	3.5	3.5	3.0	3.0
Assessment Score	/ 25	23.0	22.0	20.2	20.2	18.7	18.7
Assessment Score	/ 100	92.0	88.0	80.8	80.8	74.8	74.8
Weighted Score	/ 3.75	3.5	3.3	3.0	3.0	2.8	2.8

Noise and vibration

Ambient noise monitoring

In order to characterise the noise environment across the project area (in relation to building and operation targets) and to establish existing ambient noise levels upon which to base the noise emission targets, environmental monitoring was performed at representative locations within the project area.

The noise monitoring locations were selected to be representative of receptors and communities potentially affected by the construction and operation of each option. Noise monitoring equipment was deployed with consideration of other noise sources that may influence the measurements, accessibility and security, and with the consent of relevant landowners. The noise monitoring locations are shown in figure 6.7.



Figure 6.7: Noise monitoring locations

Operational noise

For traffic operating on public roads, the NSW Government's Road Noise Policy (RNP) provides a framework with which to assess potential road traffic noise impacts.

The RNP noise criteria aim to protect amenity inside and immediately around permanent residences, schools, hospitals and other sensitive land uses rather than at all points in a specific location, which would not be practical.

For this project, which is categorised as a redevelopment in the RNP, the following criteria are used to assess operational noise:

- During daytime hours (7am – 10pm) – $L_{a_{eq}}$ (15hour) of 60dBA
- During night time hours (10pm – 7am) - $L_{a_{eq}}$ (9hour) of 55dBA.

In addition to these criteria, the RNP identifies a 'Relative Increase Criteria' of 12dB above existing traffic noise. For any of the concept options to achieve this level of noise increase on this project, a 16-fold increase in traffic would need to occur. As a result, this criteria was not considered further.

Assessment

A three-dimensional computer noise model was developed using SoundPLAN acoustic software to model the operational noise impacts of each concept option on sensitive receivers within the study area. Noise levels were predicted for 46 residences located within the study area.

The following approach was adopted to provide a comparative assessment of each concept option:

- Calculate the weighted number of dwellings according to noise level, which is a function of the level of noise and the corresponding percentage of people who become highly annoyed

when exposed to this noise level

- Calculate the weighted number of dwellings according to increases in noise level
- Combine the total number of dwellings in the above two steps to reach an overall impact value
- Convert this overall impact to an assessment score using the following formula:
 - $(1 - \text{overall impact value}) / \text{number of residences}$.

A summary of the simulation results is provided in table 6.15.

Table 6.15: Operational noise modelling results

Concept Option	Weighted Number of Residences		
	Noise Level	Noise Increase	Total
Option A - Single stacking	15.04	1.26	16.30
Option A – Double stacking	15.06	0.84	15.90
Option B – Single stacking	14.92	3.72	18.64
Option B – Double stacking	15.00	3.90	18.90
Option C (Refined) – Single stacking	14.92	3.21	18.13
Option C (Refined) – Double stacking	14.92	3.71	18.63

The converted assessment scores are provided in table 6.16.

Table 6.16: Summary of noise and vibration assessment

Objective	Score	Option A		Option B		Option C (Refined)	
		Single	Double	Single	Double	Single	Double
Operational noise impacts	/ 100	64.6	65.4	59.5	58.9	60.6	59.5
Assessment Score	/ 100	64.6	65.4	59.5	58.9	60.6	59.5
Weighted Score	/ 3.75	2.4	2.5	2.2	2.2	2.3	2.2

6.5 Assessment category: built / cultural environment

Heritage

The Gunnedah Maize Mill and grounds represents the only heritage site within the study area. The Mill is not listed on the State Heritage Register but is listed on Gunnedah Shire Council's Local Environmental Plan.

Heritage investigations in the study area undertaken during May 2013 did not identify any further historical heritage items of significance nor any items of potential Aboriginal heritage significance. As such, the further investigations regarding the preliminary options to date have been focussed on the Mill.

Based on the investigation works, a set of nine criteria has been developed to assess the impact of each option on the heritage values and aspects in relation to the Mill:

- The physical / visual connection to the township of Gunnedah (connection to the west)
- The physical/visual connection to the rail line (connection to the south)
- Key views of the Mill:
 - From the town
 - From the rail line and the Oxley Highway
 - From Pensioner's Hill
 - From Warrabungle Street
- Physical preservation of the entire grounds
- The physical setting of the Mill in the landscape
- The retention of vegetation and screening elements.

The weighting of each criteria has been separated into three tiers relative to their importance. The views and physical connection between the Mill and the township are considered the most important, based on the historic connections between the Mill and the township and the function of the Mill within the historic and contemporary Gunnedah landscape. Table 6.17 provides a summary of the heritage assessment.

Table 6.17: Summary of the heritage assessment for each option

Objective	Score	Option A		Option B		Option C (Refined)	
		Single	Double	Single	Double	Single	Double
Physical / visual connection to township of Gunnedah	/ 15	2	0	10	8	15	12
Physical / Visual connection to the rail line	/ 15	10	8	4	2	4	2
Key view from the town	/ 15	5	0	10	8	15	12
Key view from the rail line and the Oxley Highway	/ 15	12	10	8	8	4	2
Physical preservation of the entire grounds	/ 10	10	10	8	8	8	8
Physical setting of the Mill in the landscape	/ 10	2	0	4	2	8	6
Retains screening and soft edges	/ 10	2	0	4	2	10	8
Secondary key view from Pensioner's Hill	/ 5	3	2	2	1	2	1
Secondary key view from Warrabungle Street	/ 5	3	2	3	2	5	4
Assessment Score	/ 100	49	32	53	41	71	55
Weighted Score	/ 3.75	1.8	1.2	2.0	1.5	2.7	2.1

Visual amenity and urban design

Context and approach

As part of the desktop and site analysis of the study area, five key urban design objectives were identified that will provide the basis for assessing the performance of each shortlisted option.

These are:

- Develop a concept that responds to, and respects the unique setting of the town of Gunnedah
- Locate structures so that they do not obstruct key views or vistas that give the town and the landscape character its quality
- Mitigate impacts to sensitive environs such as the floodplain, heritage elements, koala habitats and local residences

- Create effective infrastructure links for Oxley Highway traffic to residential areas with user-friendly facilities for pedestrians and cyclists
- Develop a scheme that is compatible with the desired future character and land use of the township.

The assessment of each option against the above objectives is based on its landscape character impact and visual impact.

The landscape character impact is based on the aggregate of an area's built, natural and cultural character and sense of place. In this regard, it is measured by the combination of the area's sensitivity and the magnitude (scale, character and distance). As part of the sensitivity assessment, public perception of the project, its absorption capacity and the area's significance have been taken into account.

The visual impact is based on specific viewpoints taking into consideration the sensitivity of the viewer as well as the visual effect or magnitude of the proposal based on scale, distance and contrast.

For the purposes of assessment, seven landscape character zones have been identified and are illustrated in figure 6.8 below.

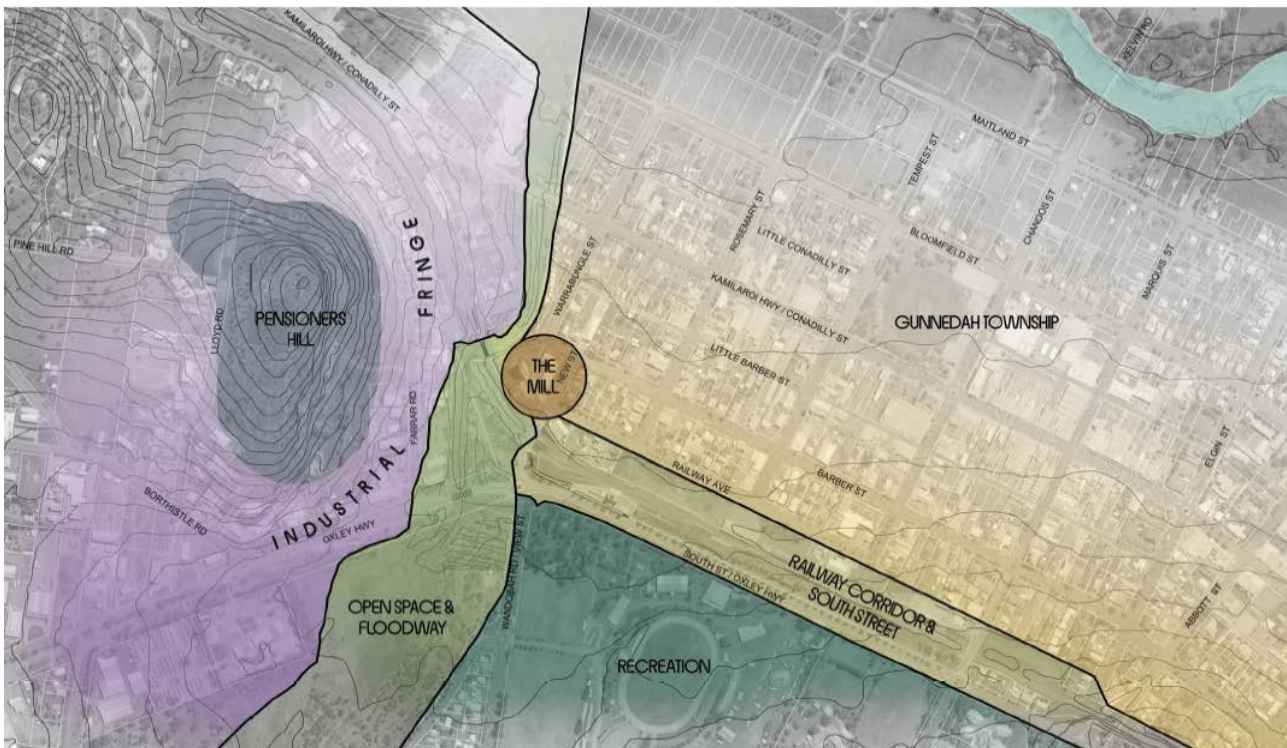


Figure 6.8: Landscape character zones

Industrial fringe

This zone occupies the foot of Pensioner's Hill and comprises predominantly commercial properties with warehouse-type buildings in a slightly elevated position compared with town. It is considered a low sensitivity area due to its utilitarian character and commercial land use.

Option A would benefit from a screening effect of the floodplain vegetation and the Mill that would spatially disconnect the proposed bridge from this zone. Only partial views from key viewpoints would be attainable and the bridge would have no impact on the overall sense of place of the industrial fringe.

The position of Option B and Option C (Refined) relative to the floodplain would create a more dominant structure that would impact some views towards the mill from this zone. However, it would not considerably change the character of the zone.

Gunnedah township

This zone comprises the urban zone north of the rail corridor and is characterised by a mixture of small residential properties and commercial warehouse-type properties on larger lots. The disparity of built form elements and mixed land use creates a non-cohesive character that limits its visual appeal. It is considered a moderately sensitive area.

Option A would create severance between the Mill and sections of the township that is considered significant as it would influence the spatial and visual relationship of the Mill and town centre. However, other areas such as Warrabungle Street would maintain their spatial connectivity and visual exposure. Overall, it is unlikely that this option will fundamentally change the identity or functionality of the township.

Option B passes behind the Mill, meaning there is no severance between the Mill and the township. However, as this option maintains a close proximity to the Mill, it intrudes on the buffer setting of the Mill to the west, which will impact on significant viewsheds.

Option C (Refined) again passes behind the Mill meaning there is no severance between the Mill and the township. This alignment is partially screened by the floodplain vegetation and provides a greater buffer zone with the Mill to the southwest.

Recreation

The Gunnedah Showground occupies land south of South Street. This zone is considered an important tourist attraction which offers a wide range of recreational activities. It is characterised by a dominant green setting with large shed/stable type buildings scattered around the property. It is considered a highly sensitive area due to its significance to the township and its intrinsic connection with rural Australia.

All three options (A, B and C (Refined)) are spatially disengaged from this zone due to their proximity to South Street, the Oxley Highway and the railway corridor which strongly delineate the town centre.

Railway Corridor and South Street

This zone has a strong linear identity and infrastructure character which greatly influences the urban permeability of the township. South Street, with its row of eucalypts, creates a strong marker that accentuates this situation. There are two significant built form elements within this zone; the heritage-listed train station and the silos at the end of Rosemary Street. These two buildings are

considered significant structures that underpin the character and sense of place of Gunnedah, making this a moderate to highly sensitive zone. figure 6.9 below illustrates the impacts each option will have on this setting.

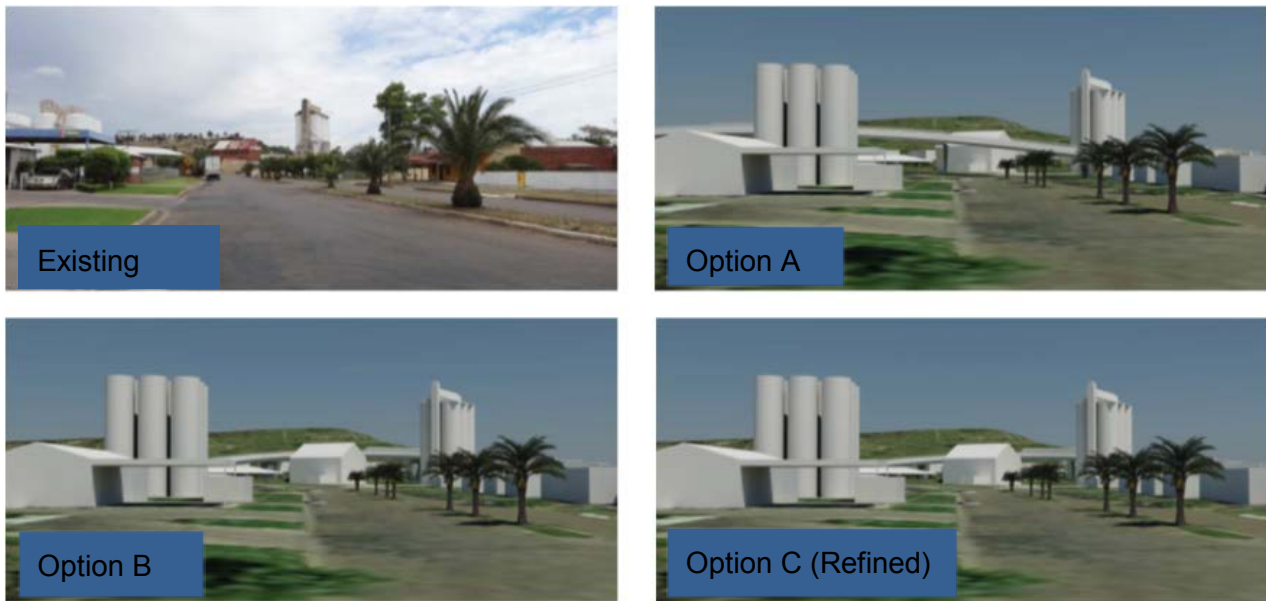


Figure 6.9: Visualisation of impacts for each double stacking option

There is a significant secondary view from South Street / Oxley Highway towards the Mill. Option A significantly impacts this setting, which is a contributor to the identity and sense of place of the township. This is illustrated in figure 6.10.



Figure 6.10: Visualisation of impacts from Option A double stacking arrangement

Although Option B limits the direct impact on this secondary view due to its location west of the Mill, it will still strongly affect the Mill setting due to its close proximity to the site. Contrastingly, Option C (Refined) limits the impacts on the Mill setting and critical views due to its location west of the Mill and significantly increased buffer zone.

Open Space and Floodway

Blackjack Creek is situated along the interface of two different geological areas and marks the entry point into the township travelling from the west. This strong green demarcation in the form of a floodway is visually and environmentally of high significance and defines the western edge of the central part of town. It is considered to be a highly sensitive zone due to its strategic position within Gunnedah, its environmental values and aesthetic appeal. This is illustrated in figure 6.11.



Figure 6.11: Visualisation of impacts from Option C (Refined) double stacking arrangement

Option A, passing east of the Mill does not impact on the floodplain setting and has no influence on its visual appeal.

Options B, however, encroaches on the floodplain setting and therefore impacts its character and visual appeal. This is particularly evident north of the railway line.

The Option C (Refined) alignment also encroaches on the floodplain but does so for a significantly longer length than Option B.

Pensioner’s Hill

As a popular destination for picnics, Pensioner’s Hill Reserve offers panoramic views of the town and beyond. This zone is considered to be highly sensitive as it strongly contributes to the identity of Gunnedah. This is illustrated in figure 6.12.

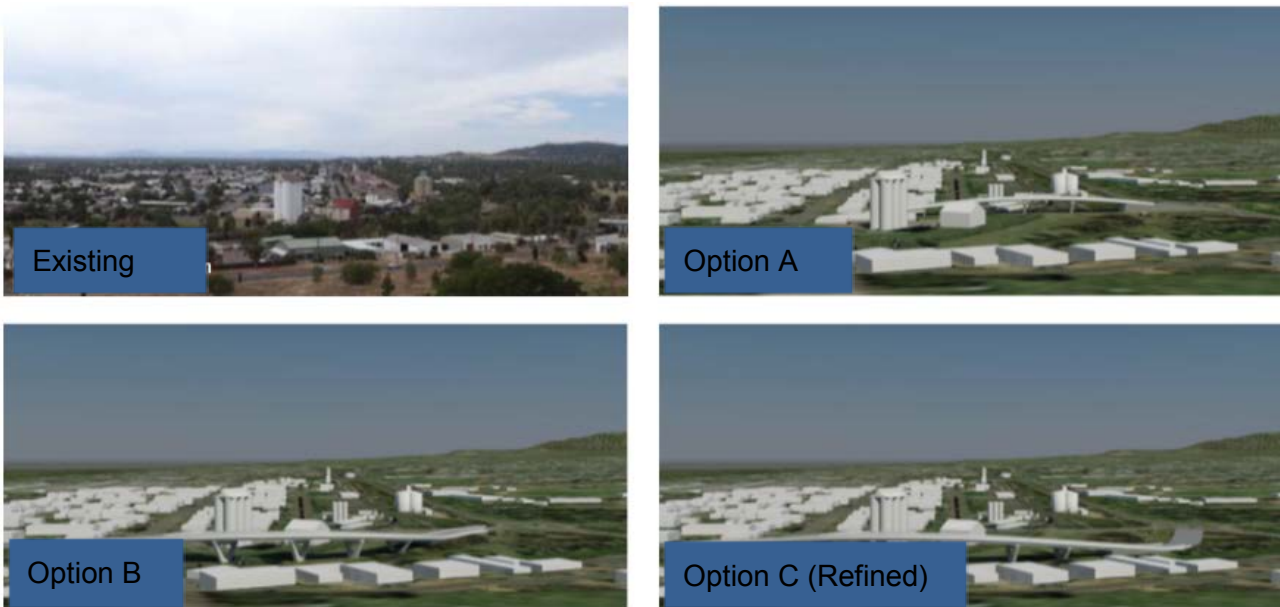


Figure 6.12: Visualisation of impacts for each double stacking option

Option A, which runs east of the Mill would not fundamentally change the sense of place and the predominant panoramic setting of Pensioner’s Hill. It will, however, impact on one of the primary views from Pensioner’s Hill to the town centre but the Mill will continue to dominate the mid ground.

Options B would provide a greater structural presence as its alignment runs west of the Mill and would contribute to a more urbanised character. However, it is not considered that this would fundamentally change the sense of place and character of Pensioner's Hill.

Option C (Refined) provides a similar alignment, although the additional buffer between to the Mill helps to mitigate the visual impact of this setting.

The Mill

The ensemble of the main brick building and silos create a strong landmark within the township. Its setting directly adjacent to the floodplain and Pensioner's Hill reinforces the connection between the natural and cultural elements, a characteristic that contributes to defining Gunnedah. This is considered a highly sensitive zone due to this spatial and visual relationship.

Option A is located in close proximity to the Mill and creates a significant visual severance from the town centre.

Option B, running west of the Mill does not create severance with the town centre as in Option A. However, due to its close proximity to the Mill, it generates competing visual elements from critical viewpoints.

Option C (Refined), however, is situated a greater distance from the Mill. The presence of existing vegetation provides some screening, which significantly reduces the impact of this option.

Assessment

Based on the qualitative assessment outlined above, the performance of each option against the five key urban design criteria has been summarised in table 6.18 below.

Table 6.18: Summary of visual amenity and urban design assessment

Objective	Score	Option A		Option B		Option C (Refined)	
		Single	Double	Single	Double	Single	Double
Develop concept that responds to & respects unique setting of town	/ 5	2	1.5	1.5	2	3.5	3
Locate structures to not obstruct key views / vistas that give town & landscape character its quality	/ 5	1	1	2	2	4	3.5
Mitigate impacts to sensitive environs such as floodplain, heritage elements, koala habitats, local residences etc.	/ 5	2	2	1	1	3	3
Create effective infrastructure links for Oxley Hwy traffic to residential areas with user friendly facilities for pedestrians and cyclists	/ 5	3	2	2	1	5	4
Develop scheme that is compatible with the desired future character & land use of the township	/ 5	2	1	3	3	4	4
Assessment Score	/ 25	10	7.5	9.5	9	19.5	17
Assessment Score	/ 100	40	30	38	36	78	70
Weighted Score	/ 8.75	3.5	2.6	3.3	3.2	6.8	6.1

Community, property and business impacts

Following the community and stakeholder consultation (as discussed in section 4), preliminary socio-economic investigations and review of preliminary specialist studies discussed in earlier sections of this report, a number of potential community, property and business impacts were identified. These are discussed below.

Potential impacts and mitigation feasibility

Potential socio-economic impacts and associated mitigation measures were divided into four categories and assessed for the six options:

- Property impacts (including acquisition, amenity and accessibility)
- Business impacts
- Visual amenity and natural environment

- Access and connectivity.

Key potential impacts (positive and negative) for the single-stack options are summarised as follows:

Option A

- No direct property impacts
- In-direct amenity-related property impacts to residences on New Street
- Impacts to property access, and passing trade for businesses
- Steep gradients difficult to access for non-motorists
- Change in local character between then Gunnedah Maize Mill (the Mill) and the township
- New structure influencing the visual environment.

Option B

- Minor direct property impacts to two properties (Marcroft Park and the Mill)
- In-direct amenity-related property impacts to residences in close proximity to the new bridge on Stockman Close, Warrabungle Street, Barber Street and Marcroft Park
- Closure of the New Street level crossing to vehicles, pedestrians and cyclists. Pedestrians and cyclists to use the upgraded Marquis Street level crossing.
- Impacts to native vegetation, open space and koala habitat
- Change to the visual environment negatively influencing the heritage values of the Gunnedah Maize Mill.

Option C (Refined)

- Similar impacts to Option B in relation to private property acquisition and the environment.
- In-direct amenity-related property impacts to residences in close proximity to the new bridge on Stockman Close, Warrabungle Street, Barber Street and Marcroft Park

Reduced impacts to the local character impacting on the heritage value of the Mill. Double-stack options were found to have similar potential impacts as per the single-stack options, however, the amenity-based impacts, in particular impacts to local character and visual amenity, and were increased with the increased height.

In general, measures for mitigating social-economic impacts can either be incorporated in the future concept design and/or developed further in the environmental assessment for all six short-listed options. Option A was identified as the most difficult option to mitigate for key socio-economic objectives, particularly due to the steep gradients and close proximity to buildings. Potential land acquisition impacts to the Mill land for options B and C (Refined).

Comparative analysis

The outcome of the comparative analysis of community, property and business impacts is shown in table 6.19 below.

Overall, among the single stack options, Option C (Refined) (Single) scored the best (83/100), as it best met the key community concerns and objectives for the project relating to accessibility to property and business impacts by keeping the New Street crossing open (subject to approval by ARTC).

Option B (Single) scored second (61/100), in particular due to potential impacts resulting from the closure of the level crossing for vehicles and proximity to the Mill.

Option A (Single) closely followed with the least favourable score (57/100), predominately due to potential amenity impacts and change to the local character of the area resulting in several potential socio-economic impacts.

Double-stacking options scored very similar to their paired single stacking option, as the footprint generally remains the same, scoring Option A (51/100), Option B (58/100) and Option C (Refined) (80/100).

However, in the areas of amenity and local character, the options scored lower due to the increased height associated and presence of the double stack option.

Table 6.19: Summary of community, property and business impact assessment

Objective	Score	Option A		Option B		Option C (Refined)	
		Single	Double	Single	Double	Single	Double
Develop an option that minimises impact to private property through acquisition	/ 20	20	20	18	18	16	16
Locate bridge to minimise impact on passing trade to businesses on surrounding streets	/ 20	10	10	5	5	18	18
Minimise potential impacts upon local amenity of residences directly affected by aspects such as noise and vibration, air quality and light spill and visual environment.	/ 20	5	2	16	14	16	14
Locate the new bridge so that accessibility to property generally can be maintained for present and future development use.	/ 20	10	10	8	8	18	18

Objective	Score	Option A		Option B		Option C (Refined)	
		Single	Double	Single	Double	Single	Double
Develop an option that minimises significant changes to the local character of the area, including the heritage value of the Mill.	/ 10	5	4	6	5	8	7
Provide accessibility for pedestrians, cyclists and disabled moving within local area.	/ 5	3	2	5	5	5	5
Develop an option that minimises impact to natural values (koala habitat and Open space) which exist in the local environment to ensure the area remains amenable for residents and tourists and aligns with community nature values.	/ 5	4	3	3	3	2	2
Assessment Score	/ 100	57	51	61	58	83	80
Weighted Score	/ 12.5	7.1	6.4	7.6	7.3	10.4	10.0

6.6 Assessment category: value

Capital cost

Capital cost estimates were developed for each concept option in accordance with the Roads and Maritime Estimating Manual. Table 6.20 provides a summary of the estimate results, noting that a high contingency of 40 per cent was used for this assessment due to the strategic level of the cost estimates.

Table 6.20: Indicative cost estimate summary

Item	Option A		Option B		Option C (Refined)	
	Single	Double	Single	Double	Single	Double
Project Development	\$0.54 M	\$0.57 M	\$0.71 M	\$0.72 M	\$0.65 M	\$0.75 M
Detail Design / Documentation	\$0.85 M	\$0.89 M	\$1.12 M	\$1.14 M	\$1.03 M	\$1.19 M
Property Acquisitions	\$0 M	\$0 M	\$0.11 M	\$0.11 M	\$0.11 M	\$0.11 M
Infrastructure Build	\$21.20 M	\$22.25 M	\$27.98 M	\$28.42 M	\$25.67 M	\$29.82 M

Finalisation	\$0.42 M	\$0.43 M	\$0.52 M	\$0.52 M	\$0.48 M	\$0.55 M
Preliminary Total	\$23.01 M	\$24.14 M	\$30.43 M	\$30.91 M	\$27.94 M	\$32.42 M
Total Including Contingency	\$32.21 M	\$33.80 M	\$42.60 M	\$43.27 M	\$39.11 M	\$45.39 M
Indicative Cost Estimate	\$33 M	\$34 M	\$43 M	\$44 M	\$45 M	\$46 M

NOTE: The above estimates are based on initial strategic concept design and high contingency and have been significantly reduced with further design development (see section 10).

The comparative assessment undertaken for capital costs, applies a formula where the lowest capital cost option receives a base line score of 100 per cent. All subsequent concept options are scored as a direct proportion to this base line, using the following formula to determine an assessment score, summarised in table 6.21 below:

$$1 - [(option\ estimate / lowest\ estimate) - 1] * 100$$

Table 6.21: Summary of capital cost assessment

Objective	Score	Option A		Option B		Option C (Refined)	
		Single	Double	Single	Double	Single	Double
Capital cost estimate	/ 100	100	97	70	67	64	61
Assessment Score	/ 100	100	97	70	67	64	61
Weighted Score	/ 13	13	12.6	9.1	8.7	8.3	7.9

Lifecycle costs and benefits

Road-based transport options are commonly appraised using a Road User Cost Benefit Analysis. This is a specific form of a traditional cost-benefit assessment that defines and measures the key benefits of each concept option as reductions in the following:

- Vehicle travel time costs
- Vehicle operating costs
- Accident costs
- Cost of environmental and social effects from vehicle use (external costs).

These user benefits have been determined based on estimates made of the travel time and vehicle kilometres for travel under each of the concept options using the Roads and Maritime Estimating Manual as a framework for this process.

The Net Present Value provides a present day assessment of each concept option that incorporates the initial capital expenditure, together with ongoing future maintenance, operational,

replacement and disposal costs over an evaluation period of 30 years using an applied discount rate of seven per cent. The results of this assessment are detailed in table 6.22 below.

Table 6.22: Summary of road user costs and benefits (Option C (refined) does not the Barber Street intersection costs)

Cost Benefit Item	Option A		Option B		Option C (Refined)	
	Single	Double	Single	Double	Single	Double
Capital costs (infrastructure only)	\$19.02 M	\$19.96 M	\$25.10 M	\$25.50 M	\$26.27M	\$26.76
Maintenance costs	\$0.38 M	\$0.38 M	\$0.44 M	\$0.44 M	\$0.48 M	\$0.48 M
Operational costs	\$0.01 M	\$0.01 M	\$0.01 M	\$0.01 M	\$0.01 M	\$0.01 M
Replacement costs	\$0.41 M	\$0.41 M	\$0.56 M	\$0.56 M	\$0.64 M	\$0.64 M
Disposal costs	N/A	N/A	N/A	N/A	N/A	N/A
Total Direct Infrastructure cost	\$19.83 M	\$20.77 M	\$26.11 M	\$26.51 M	\$27.41 M	\$27.90 M
Travel time costs (savings)	\$1.41 M	\$1.41 M	\$2.54 M	\$2.54 M	\$2.39 M	\$2.39 M
Vehicle operating costs (savings)	\$1.14 M	\$1.14 M	\$2.05 M	\$2.05 M	\$1.91 M	\$1.91 M
Stop costs (savings)	\$0.33 M	\$0.33 M	\$0.33 M	\$0.33 M	\$0.33 M	\$0.33 M
Crash costs (savings)	\$0.22 M	\$0.22 M	\$0.40 M	\$0.40 M	\$0.38 M	\$0.38 M
Environmental costs (savings)	\$0.01 M	\$0.01 M	\$0.42 M	\$0.42 M	\$0.39 M	\$0.39 M
Total road user benefits	\$3.11 M	\$3.11 M	\$5.75 M	\$5.75 M	\$5.40 M	\$5.40 M
Net Present Value	(\$16.72 M)	(\$17.66 M)	(\$20.37 M)	(\$20.76 M)	(\$22.01 M)	(\$22.50 M)
Benefit – Cost Ratio	0.16	0.15	0.22	0.22	0.20	0.19

Assessment

The combined NPV and cost benefit assessment provides a snapshot of the overall economic value of each concept option. It should be noted that in locations such as Gunnedah, where traffic volumes are low, it is difficult to present an economic case where the road user benefits outweigh the capital cost of the infrastructure.

This is the case for this project as the benefit-cost ratios for each concept option are all substantially less than one, the point at which the economic benefits of an option are considered to outweigh the upfront costs. The results, therefore, should be considered comparatively and in the context of the broader project objectives.

For the purposes of this comparative assessment, the benefit-cost ratios have been used as the basis for scoring each option. A ratio of one is considered an excellent performing economic option given the context of this project, with ratios less than this scored proportionally. Table 6.23 summarises the results of this assessment.

Table 6.23: Summary of lifecycle costs and benefits assessment

Objective	Score	Option A		Option B		Option C (Refined)	
		Single	Double	Single	Double	Single	Double
Benefit cost ratio	/ 100	16	15	22	22	20	19
Assessment Score	/ 100	16	15	22	22	20	19
Weighted Score	/ 7	1.1	1.1	1.5	1.5	1.4	1.3

6.7 Assessment results

The results of the independent MCA criteria assessments have been documented in sections 6.2–6.6.

This section provides the results of the combined MCA process used to identify a recommended option for further consideration and comment by key stakeholders and the community.

Qualitative results

For context and to provide a base line with which to critique the results of the assessment and weighting process, a general overview of the individual results is provided in this section.

Table 6.24 summarises the outcomes from the 14 individual criteria assessments. Rather than providing numerical scores, the table bands the results together to give an indication of which options performed well and which ones performed poorly across the criteria without bias due to the weightings that are applied.

Green shading indicates an option performs well across specific criteria, orange shading indicates an option performs adequately and red shading indicates an option performs poorly.

For each option, single stacking clearances are marginally better performed than the double stacking equivalent, but only for select criteria. This is expected as many of the criteria do not differentiate between the two clearances, whereas others, such as cost and visual-related assessments will favour the lower clearance bridge.

Option A – single and double stacking

The results for Option A are polarising. For some criteria the option is best performed and in others it is by far the worst performed.

Criteria that are largely influenced by Blackjack Creek, such as flooding and ecology, rank Option A favourably. Likewise, cost-related criteria favour the shorter alignment of Option A.

However, criteria relating to design, constructability and visual appearance all have very negative results in comparison to options B and C (Refined).

Option B – single and double stacking

Option B is very similar to Option C (Refined), however, it performs worse than Option C (Refined) for criteria considering noise impacts, heritage impacts, visual appearance and community and business impacts. It subsequently performs worse than Option A for criteria relating to cost and issues influenced by Blackjack Creek

This is an expected result as this option has an alignment close to the Mill without a buffer and does not provide a direct vehicle access to Barber Street.

Option C (Refined) – single and double stacking

The results for Option C (Refined) are also quite uniform. For most criteria Option C (Refined) generates average or good results in comparison to Option A and Option B.

Option C (Refined) provides many features that are found in Option A and Option B. However, with the alignment to the west of the Mill, visual and heritage impacts are minimised.

Option C (Refined) ranked favourably with criteria relating to community and business impacts, design performance and visual amenity.

Option C (Refined) performs less favourably in relation to cost related criteria and has a more significant impact on criteria related to Blackjack Creek. It is worth noting, however, that with the exception of the economic evaluation of costs and benefits, Option C (Refined) rates well against any other criteria and has at least a fair or better rating across all remaining criteria.

MCA scoring outcomes

Table 6.25 presents the raw and weighted scores for each concept option against the 14 individual MCA criteria assessments.

The double stacking configuration of Option C (Refined), with a total weighted score of 64.6/100 is the second highest scoring option.

The results ended with a very tight range of scores - 53.4 to 68.0. No single concept option provided the best solution against all criteria, which is an expected result due to the significant and varied nature of the constraints. Therefore the variability in performance of each option across all criteria is consistent with a close overall spread of assessment scores.

It is worthwhile noting that the overall scoring difference between the single and double stacking options for Option C (Refined) was only 3.4 per cent. This is a very small difference in scores and a reflection of the fact that only a small number of criteria were impacted differently by the two clearances.

Table 6.24: Banded MCA assessment results

Assessment Category	Engineering		Traffic, Transport & Safety				Natural Environment			Built / Cultural Environment			Value	
	Design Performance	Constructability & Staging	Vehicle & Road Safety	Traffic Flow & Connectivity	Pedestrian & Cyclist Access	HML Network Efficiency	Ecology	Flooding & Drainage	Noise & Air Quality	Heritage	Visual Amenity / Urban Design	Community & Business Impacts	Capital Cost	Lifecycle Costs & Benefits
MCA Assessment Criteria														
Option A (Single Stacking)	☐☐	☐	○	☐	○	○	☐☐	☐☐	☐	○	☐	○	☐☐	☐☐
Option A (Double Stacking)	☐☐	☐	☐	☐	☐	○	☐☐	☐☐	☐	☐	☐	○	☐☐	☐☐
Option B (Single Stacking)	☐☐	○	○	☐	○	☐	☐	☐☐	○	○	☐	☐	☐	☐
Option B (Double Stacking)	☐☐	○	○	☐	○	☐	☐	☐☐	○	☐	☐	○	☐	☐
Option C (Refined) (Single Stacking)	☐☐	○	○	☐☐	○	☐☐	☐	☐	☐	☐	☐	☐☐	☐	☐
Option C (Refined) (Double Stacking)	☐☐	○	○	☐☐	○	☐☐	☐	☐	○	○	☐	☐	☐	☐☐

☐☐	81 – 100 (Excellent)	☐	21 – 40 (Fair)
☐	61 – 80 (Good)	☐☐	0 – 20 (Poor)
○	41 – 60 (Average)		

Table 6.25: Overall MCA scoring results

Assessment Category	Engineering		Traffic, Transport & Safety				Natural Environment			Built / Cultural Environment			Value		
Overall Assessment Weighting	10		30				15			25			20		
MCA Assessment Criteria	Design Performance	Constructability & Staging	Vehicle & Road Safety	Traffic Flow & Connectivity	Pedestrian & Cyclist Access	HML Network Efficiency	Ecology	Flooding & Drainage	Noise & Air Quality	Heritage	Visual Amenity / Urban Design	Community & Business Impacts	Capital Cost	Lifecycle Costs & Benefits	Totals
Itemised Weighted Criteria	6	4	10.5	9	7.5	3	7.5	3.75	3.75	3.75	8.75	12.5	13	7	100
Option A (Single Stacking)	0.9	1.3	4.7	5.8	3.8	1.5	7.3	3.5	2.4	1.8	3.5	7.1	13.0	1.1	57.7
Option A (Double Stacking)	0.9	1.0	4.2	5.8	3.0	1.5	7.3	3.3	2.5	1.2	2.6	6.4	12.6	1.1	53.4
Option B (Single Stacking)	5.1	2.1	6.3	7.2	4.5	2.1	5.6	3.0	2.2	2.0	3.3	7.6	9.1	1.5	61.6
Option B (Double Stacking)	5.1	2.1	5.3	7.2	4.1	2.1	5.6	3.0	2.2	1.5	3.2	7.3	8.7	1.5	58.9
Option C (Refined) (Single Stacking)	5.4	2.2	5.8	7.6	4.1	2.7	5.5	2.8	2.3	2.7	6.8	10.4	8.3	1.4	68.0
Option C (Refined) (Double Stacking)	5.4	2.2	4.7	7.6	4.1	2.7	5.5	2.8	2.2	2.1	6.1	10.0	7.9	1.3	64.6

Recommended option

Based on the results of the MCA process, the single stacking configuration of Option C (Refined) returned the highest score and therefore is proposed as the recommended option to take forward for further development.

This result is consistent with the qualitative review that was discussed in section 6.7 in which the unweighted criteria were compared.

7 Value management

As part of the options selection process, a value management workshop was undertaken to help guide the selection of the recommended option.

The workshop was held on 26 September 2013 and was attended by 27 representatives of the project team, Roads and Maritime and other key stakeholders including ARTC, Transport for NSW and Gunnedah Shire Council.

This workshop provided an opportunity for stakeholders and those involved in day-to-day project activities to step back and fully assess proposed directions with the aim of ensuring the strategy taken forward delivers the best overall value and meets community expectations.

7.1 Value management process

The value management workshop followed a structured process to ensure that key issues were identified and that the outcomes ultimately meet the essential project requirements. The process focussed on developing common and agreed project objectives and stakeholder requirements so that the most appropriate outcomes are achieved.

The workshop involved five distinct phases which aimed to add value to the options assessment process by achieving the following outcomes:

- Confirmation and agreement of workshop and project objectives
- Testing of the assumptions being made
- Updating participants on the shortlisted options and suggesting ideas for improvement
- Identifying the group's recommended way forward
- Creating an action plan to assign tasks and activities for further work.

Information phase

The initial stage of the workshop involved several presentations that provided relevant information regarding the project, its current status and the proposed future program for delivery in line with critical time constraints.

Following the presentation, the workshop participants were given an opportunity to respond with their understanding of the key issues that exist for this project. This approach allowed any misunderstandings to be identified and clarified, so that all participants had a similar understanding of the project, regardless of their previous level of involvement.

Analysis phase

The analysis phase of the workshop was used to gain an understanding of the underlying issues and constraints that had the potential to impact the options being considered. It allowed

participants to clarify objectives, to express concerns and to make suggestions regarding the optimum solutions.

Workshop participants were given an opportunity to discuss in detail any assumptions being made regarding the proposed options. From this discussion, the following key issues and concerns were raised which shaped the subsequent direction of the workshop discussions:

- The strategic estimate amount significantly exceeded the original budget and subsequently the project was likely to be a 'hard sell' in terms of Maritime of capital cost
- The geometry of the bridge was nearing the design limits
- The geometry of the roundabout in Option C (Refined) and how it will be able to operate safely
- Safety of road, rail and pedestrian traffic if the level crossing were to remain open.
- Subsequently resolving the differing opinions regarding the level crossing between Council, ARTC, Roads and Maritime, TfNSW and the broader community
- Meeting ecologically sustainable development objectives in relation to community and environment
- The performance of the Kamilaroi Highway and Warrabungle Street intersection and how it will operate effectively, given the traffic volumes
- Resolving whether the bridge accommodates single or double stacked trains
- The community expectation that the bridge will be built by 2016
- Ensuring the community is listened to.

Options evaluation phase

The options evaluation phase of the workshop was used to review in detail the three shortlisted options and the associated issue of the single versus double stacking requirement. The results of this process are documented below.

Single versus double stacking

The workshop participants engaged in a lengthy discussion regarding the merits of taking forward a design that would accommodate either single or double stacked rolling stock. Several key points were identified, which include:

- Coal and bulk grain are unlikely to become double stacked in the short term.
- Double stacking cannot pass through the current Sydney network
- The inland Parkes to Brisbane route will drive the decision regarding single or double stacking

- There are three options currently under consideration for the inland route from Brisbane to Melbourne, of which only one would affect Gunnedah
- The Great Australian Trunk Route will not pass through Gunnedah
- The ARTC study for the Commonwealth, 2010/11, identified an inland route which will pass through Narrabri, not Gunnedah
- The original inland route goes through Gunnedah – if this were to be developed first, five bridges on the corridor would need to be upgraded.

Ultimately, the group concluded that the most sensible approach would be to implement a single stacked solution on the basis that it could be raised in the future should the need ever arise, for the following reasons:

- The rail line through Gunnedah may never become double stacked
- There are several other structures over the line that would need to also be raised should future double stacking be adopted
- Any increase to double stacking may not occur within the design life of the project
- Single stacking clearances would provide opportunities to optimise the bridge geometry.

Comparison of shortlisted options

The three shortlisted options were considered at the workshop and the draft options report was provided to the participants prior to the session. Accordingly, the group was asked to consider these options to isolate the advantages and disadvantages associated with each. These were then discussed to assist in identifying the recommended option to be carried forward.

A detailed assessment of positive and negative impacts was undertaken for each of the three shortlisted options.

Following this discussion, the workshop participants concluded that Option A was not a viable option to progress further, due to it containing the following negative impacts:

- The minimum grade required to build this alignment was 12.7 per cent, which was considered excessive for the type of heavy vehicles which the road is intended for (The maximum design grade is 10 per cent).
- The impact on the Maize Mill, which is a heritage item and substantial structure within Gunnedah.
- Major constructability constraints associated with building the bridge over the existing level crossing.

This conclusion is consistent with the results of the detailed MCA assessment documented in section 6.

The group discussed the two remaining options (Option B and Option C (Refined)) in further detail, but no clear agreement emerged in support of either of these options.

A further assessment was undertaken using a methodology known as a ‘paired comparison’, in which each option was assessed against a series of agreed weighted criteria in what essentially equates to a simplified MCA process.

Each participant considered each of the remaining options in light of the information that had been shared in the course of the workshop and within the supplied material. Voting was then undertaken anonymously using an electronic voting tool, to establish which option most fully met the selection criteria. The results of this process are summarised in table 7.1.

Table 7.1: Paired comparison assessment of Option B and Option C (Refined)

Workshop criteria	Option B	Option C (Refined)
Road safety	60	50
Local transport efficiency	27	40
Road transport productivity, efficiency and reliability	20	20
Environmental impacts	0	0
Totals	107	110

The above results indicate that the two options are similar in their impacts and difficult to separate. This is consistent with the results of the MCA assessment outlined in section 6, in which Option C (Refined) was considered moderately better performing overall.

As a result of the close scoring between the two options at the value management workshop and the range of views expressed, the workshop participants resolved to endorse an alignment that runs west of the Maize Mill, allowing the more thorough results from the detailed MCA assessment to be used to differentiate between the two options.

Creative phase and judgement phase

Following the detailed assessment of the shortlisted options, the information was used for a general brainstorming session aimed at adding value and improving the final project outcome.

During the creative phase, the participants were encouraged to come up with ideas as to how problematic issues could be resolved. These were to be as wide ranging as possible, regardless of their apparent likelihood of being implementable.

The subsequent judgement phase was used to screen the ideas that were collected to determine their practicality, viability and cost effectiveness.

Table 7.2 below provides a summary of the ideas that were considered practical and worthwhile for further investigation prior to finalising the recommended option for the project.

Table 7.2: Value adding ideas for further post value management workshop investigation

Idea	Rationale	Responsibility
Undertake pre-planting of 'koala food trees' prior to project in accordance with Councils Plan of Management	Mitigate future environmental risks Reduce significance of impact Reduce time and cost	Roads and Maritime
Minimise width of the bridge by removing the barrier between the footpath and the roadway	Reduce cost Reduce sight distance issues	Project Team
Create left in – left out access to Barber Street	Address community concerns regarding connectivity issues	Project Team
Install traffic lights instead of roundabout at Oxley Highway	Potentially safer for Option C (Refined)	Project Team
Install a superstructure with less structural depth across railway	Potentially provide a better connection to Barber Street by lowering height of road	Project Team
Have a reduced span QLD Plank type length of 30m thereby losing 0.5m depth	Potentially provide a better connection to Barber Street by lowering height of road	Project Team
Utilise a steel trough girder solution	Eliminate skew issues Reduce costs Possibly easier construction	Project Team
Utilise piles that do not go down to bedrock	Reduce cost	Project Team
Use QLD Planks for the whole structure	Potentially reduce costs	Project Team

7.2 Workshop outcomes

Following completion of the value management process, the following outcomes were agreed:

- The recommended option would be designed to accommodate single stacking clearances only
- Option A was not viable and would not be considered in any further investigations.
- The recommended alignment will run to the west of the Maize Mill, with the MCA assessment to be used to distinguish between options B and C (Refined)
- All possibilities should be considered for maintaining access and connectivity to Barber Street. As such, an agreement on the status of the existing New Street level crossing is required prior to any endorsement of the recommended option, with alternatives to be considered should the crossing be closed to vehicles

- Further investigation and design optimisation should be undertaken to achieve the following:
 - Improve the roundabout geometry at the Oxley Highway
 - Improve design performance that are possible for single stacking clearances
 - Implement design measures to reduce project costs.

8 Post value management design optimisation

8.1 Overview and objectives

Following the value management workshop, the project team further developed the design of the recommended Option C (Refined) in an attempt to resolve the issues that remained for the project. This work included the following:

- Optimising the design for the Option C (Refined) alignment to:
 - Improve the roundabout geometry at the Oxley Highway
 - Improve the design performance of the alignment as a result of the decision to only consider single stacking clearances
 - Implement design measures to reduce project costs.
- Reviewing and considering solutions to maintain access and connectivity to Barber Street, including confirmation of the status of the existing New Street level crossing, so that impacts are understood prior to the recommended option being endorsed
- Assessing business impacts to the Barber Street Precinct should the New Street level crossing be closed and no access provided into Barber Street from the recommended Option C (Refined).

The following sections of this report document the results of these additional investigations.

8.2 Intersections investigations and optimisation

Intersections traffic demand performance

Investigations were undertaken to determine most effective traffic demand based intersection performance for the Oxley Highway/View Street and Conadilly Street / Kamilaroi Highway / Warrabungle Street intersections.

A paper published in the *Proceedings of the Eastern Asia Society for Transportation Studies, Vol.9, 2013*ⁱ on the efficiency of intersection treatment options for varying traffic conditions indicated the general advantages and disadvantages of priority-controlled (give way), roundabout and signalised intersection treatments. The paper concluded that, in general, at moderate levels of traffic demand, roundabouts outperformed all other intersection types.

The paper presented the typical levels of traffic demand that represented the cut-off for each range in which one treatment option outperformed the others.

Conclusion

Both proposed roundabout intersections fall into the favourable range for roundabouts and show superior traffic demand performance to signalised options. This result is shown in figure 8.1.

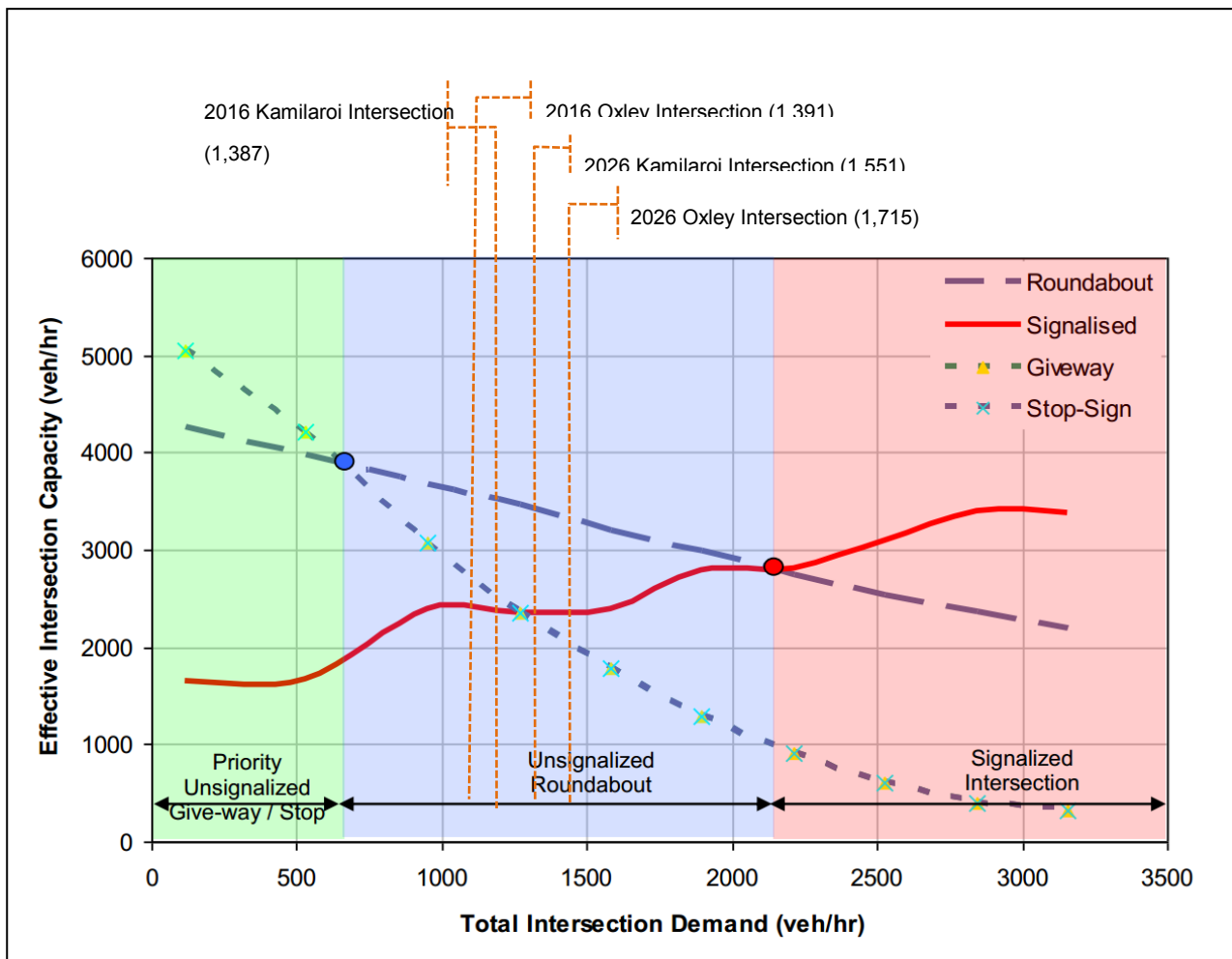


Figure 8.1: Intersection demand and effective capacity performance for proposed roundabouts

Oxley Highway / View Street intersection

Roundabout layout and size optimisation

The original Option C (Refined) design utilised a large roundabout at the Oxley Highway with a 30 metre inscribed radius.

However, concerns were raised during the value management workshop regarding the safety of large vehicles using the roundabout, given their perceived accident record when making similar turning movements on other large roundabouts in NSW.

Further investigation into this issue has concluded that providing a low entry speed (50 kilometres per hour) together with a suitable pavement cross fall will eliminate these safety concerns. However, to also reduce construction costs, consideration has been given to minimising the size of the roundabout.

Alternative roundabout configurations were investigated to determine a design that provided the best balance between potential cost savings and design performance. Conflicting objectives from stakeholders and the subsequent uncertainty of the status of the level crossing, led the project team to develop an optimised roundabout that would allow either scenario (four or five leg

roundabout) to be adopted with minimal impact on the alignment design. This optimised roundabout is illustrated in figure 8.2.



Figure 8.2: Optimised Oxley Highway roundabout

The roundabout designs with R25 metre and R20 metre inscribed circles were investigated further in relation to their central roundabout size and relative speeds between approaching and circulating the roundabout.

The ARNDT software roundabouts program referenced by Austroads was subsequently used to determine:

- Likely speeds for the roundabout options, with a reduced approach and circulating speed indicating a better performing design solution
- Outputs for vehicle accident parameters with lower figures indicating a better performing design solution.

The ARNDT program results suggest that there is no decrease in circulating vehicle speeds, entry speed or relative speed for the roundabout design with a 20 metre inscribed radius. This indicates that the R20 metre inscribed circle is too small to reduce the speeds.

Further to this, vehicle accident parameter shows a significantly superior performance for the R25m inscribed circle roundabout. These results are summarised in Table 8.1.

Table 8.1: Vehicle speeds and accident parameter comparison

Roundabout	Relative Speed	Accident Parameter
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R20m	48 – 50	176 – 186
R25m	31 - 39	87 - 127

The numerical results summarised above support the conclusion that the larger, 25 metre inscribed circle roundabout performs significantly better at reducing vehicle speeds on entry and circulation of the roundabout and as a result is a significantly safer design. The vehicle paths and relative deflection of vehicle movements are illustrated in Figure 8.3, which illustrates that the central island for the R20m inscribed circle roundabout is too small to decrease the entering and circulating traffic speeds.



Figure 8.3: Vehicle paths and relative deflections for R20 metres and R25 metre roundabouts

Following this detailed assessment a roundabout with a 25 metre inscribed circle provided the most suitable design solution from a performance, cost and safety perspective for the Oxley Highway / View Street intersection and has subsequently been adopted as part of Option C (Refined). This is a similar design to the existing roundabout located at the northern end of the Kempsey Bypass, which adequately caters for high levels of HML freight vehicle use.

Signalised intersection alternative

Signalised intersection alternative was considered and investigated for the Oxley Highway / View Street location, based on New Street level crossing closed recommended option.

PM Peak period traffic figures were used to determine the average delays and levels of service for the signalised and roundabout intersection options using the Sidra Intersection software modelling. Initial concept layout was prepared for the signalised option on the basis of the subsequent traffic advice. This is shown in figure 8.4 as an overlay on the adopted roundabout design

Based on the above traffic analysis, the roundabout options would operate at a higher level of service A, compared with level of service B with the signalised options. Further, the intersection degree saturation and the average vehicle delays are lower with the roundabout option.

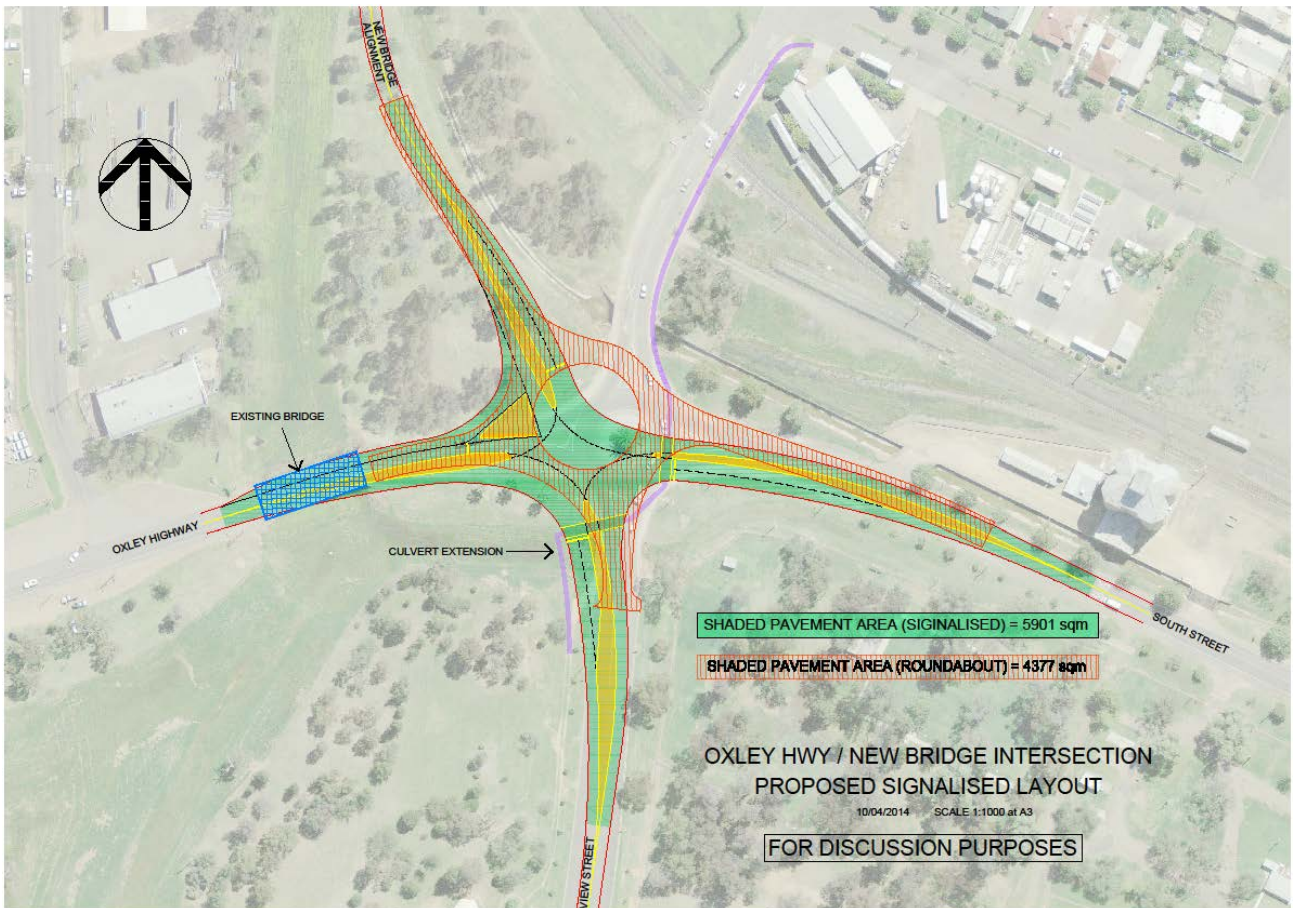


Figure 8.4: Signalised intersection alternative – Oxley Highway intersection with overlaid R25 roundabout option

The full summary of the advantages and disadvantages of the alternative intersection types is shown in table 8.2.

Table 8.2: Comparison of the roundabout and signalised options – Oxley Highway intersection

Option	Advantages	Disadvantages
Roundabout	<ul style="list-style-type: none"> Higher level of service (LOS A) and shorter average delays Better operational efficiency the signals at current and forecast traffic figures A slightly better road safety aspect then signals due to natural traffic calming effect. Potentially smoother left turn for trucks onto the bridge More cost effective then signals 	<ul style="list-style-type: none"> Limited consideration for pedestrian and cyclist movements through the intersection,
Signalised Intersection with no east to south slip lane	<ul style="list-style-type: none"> Higher level of safety for pedestrians and cyclists compared with the roundabout Sufficient capacity at current and forecast traffic figures 	<ul style="list-style-type: none"> Lower level of service B and longer average delays Larger footprint required to provide separate turning bays.

Option	Advantages	Disadvantages
(adopted for investigation)		<p>More costly, at approximately \$3.6M cost increase over the roundabout</p> <p>Longer medians and other infrastructure affect driveways access and community amenity</p> <p>More complex construction due to U/G cables and utilities conflicts</p> <p>Major drainage impact including Blackjack Creek culvert replacement</p> <p>Increased environmental impact including take-up of core koala habitat south of Oxley Highway.</p>

Conclusion

Based on the above traffic, cost, constructability and safety considerations, the roundabout option provides a superior solution, compared with the signalised option.

Conadilly Street/Kamilaroi Highway/Warrabungle Street intersection

Roundabout layout and size optimisation

The roundabout design illustrated in figure 8.5 was developed to accommodate:

- B Double design vehicle and B Triple check vehicle.
- No property acquisition.
- Allowances for pedestrian crossings.

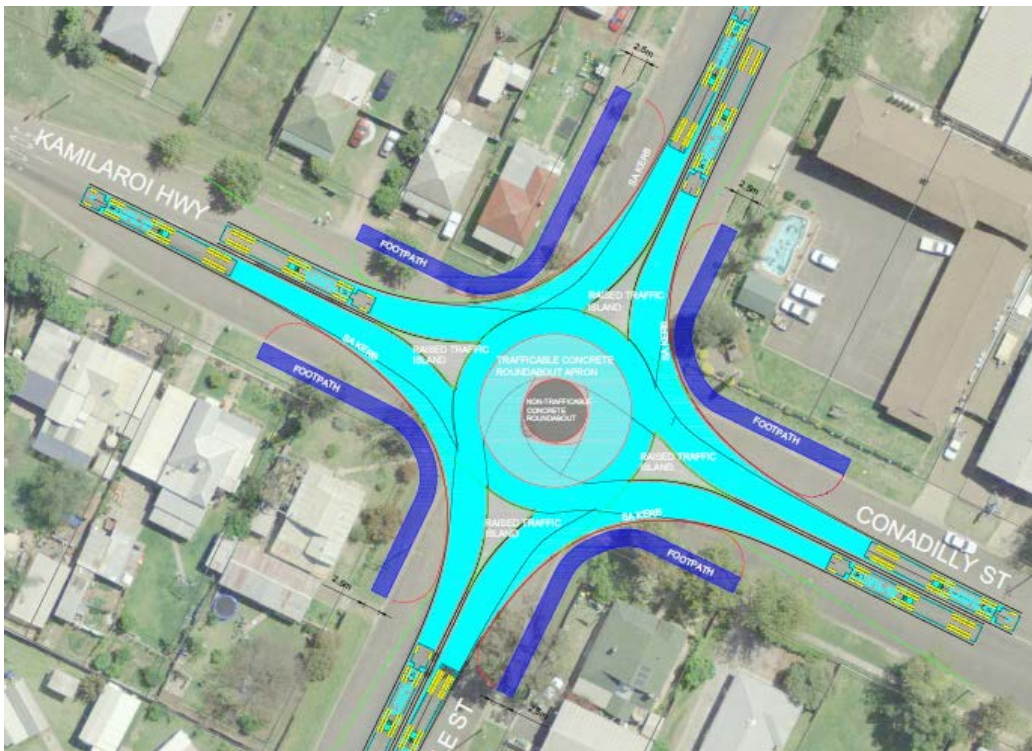


Figure 8.5: Roundabout intersection alternative – Conadilly Street / Kamilaroi Highway / Warrabungle Street

Signalised intersection alternative

Signalised intersection alternative was considered and investigated for the Conadilly Street/Kamilaroi Highway/Warrabungle Street intersection.

PM Peak period traffic figures were used to determine the average delays and levels of service for the signalised and roundabout intersection options using the Sidra Intersection software modelling. Initial concept layout was prepared for the signalised option on the basis of the subsequent traffic advice. This is shown in figure 8.6.

Based on the above traffic analysis, the roundabout options would operate at a higher level of service A, compared with level of service B with the signalised options. Further, the intersection degree saturation and the average vehicle delays are lower with the roundabout option.

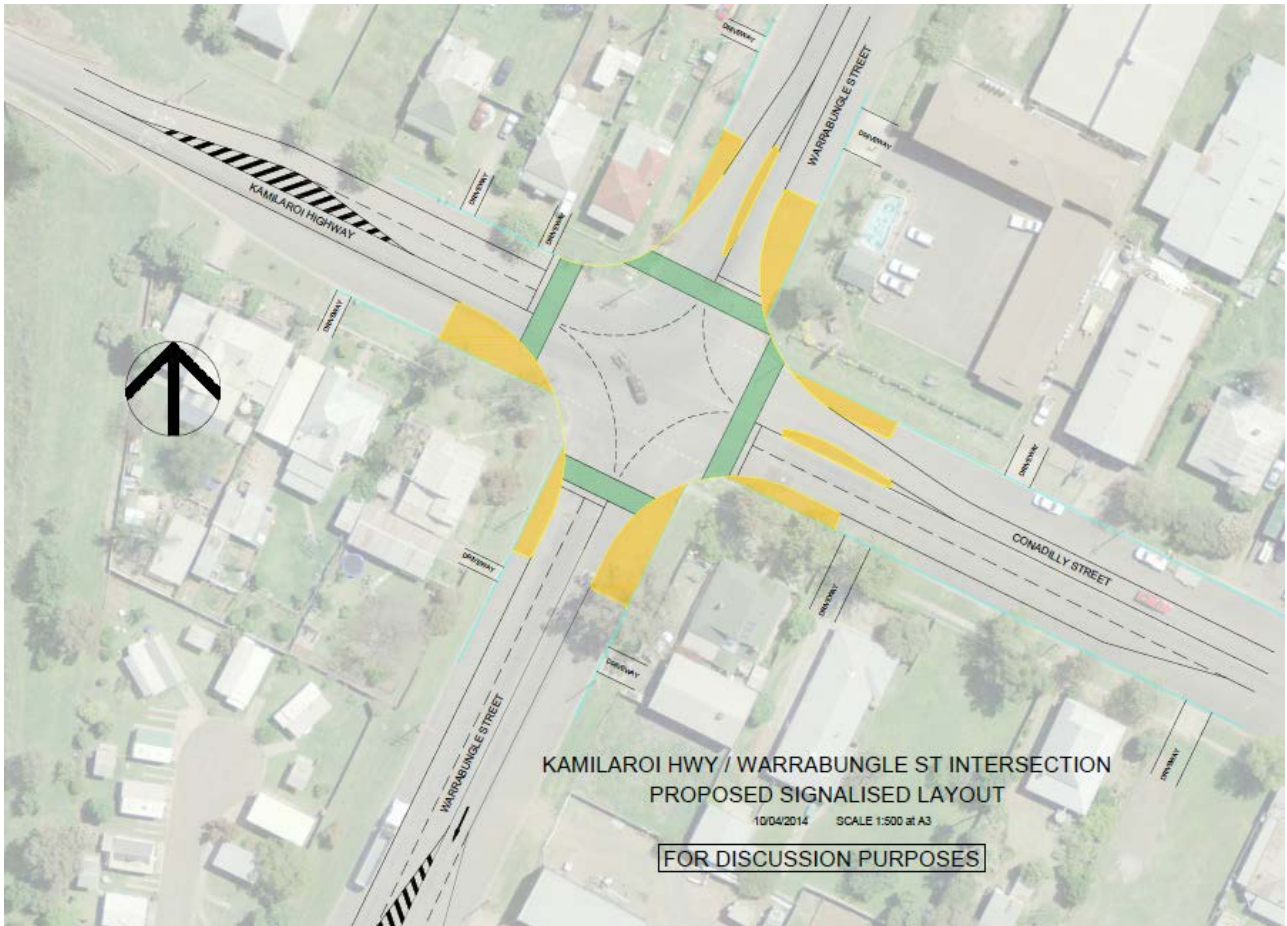


Figure 8.6: Signalised intersection alternative – Conadilly Street / Kamilaroi Highway / Warrabungle Street intersection

The full summary of the advantages and disadvantages of the alternative intersection types is shown in table 8.3.

Table 8.3: Comparison of the roundabout and signalised options – Conadilly Street / Kamilaroi Highway / Warrabungle Street intersection

Option	Advantages	Disadvantages
Roundabout	<p>Higher level of service (LOS A) and shorter average delays</p> <p>Better operational efficiency the signals at current and forecast traffic figures</p> <p>A slightly better road safety aspect then signals due to natural traffic calming effect.</p> <p>Vehicles coming from the new bridge and heading to the Barber St precinct can execute a U-turn.</p> <p>More cost effective then signals</p>	<p>Limited consideration for pedestrian and cyclist movements through the intersection</p>
Signalised Intersection with no east to south slip lane (adopted for investigation)	<p>Higher level of safety for pedestrians and cyclists compared with the roundabout</p> <p>Sufficient capacity at current and forecast traffic figures</p>	<p>Lower level of service B and longer average delays</p> <p>Larger footprint required to provide separate turning bays.</p> <p>More costly, at approximately \$0.7M cost increase over the roundabout</p> <p>Longer medians and other infrastructure affect driveways access and community amenity</p> <p>More complex construction due to U/G cables and utilities conflicts</p>

Conclusion

Based on the above traffic, cost, constructability and safety considerations, the roundabout option provides a superior solution, compared with the signalised option.

Alignment refinements to Option C (Refined)

The original alignment of Option C (Refined) provided a wide arc from the Oxley Highway to the west of the Gunnedah Maize Mill. This arc allowed a considerable visual and heritage buffer to be provided between the proposed road and the Mill and allowed for a crossing of the railway to be provided with minimal skew.

However, concerns were raised during the value management workshop regarding the movement of vehicles travelling south over the railway and the need to make a sharp turn to then travel west along the Oxley Highway.

As a result of these concerns, the Option C (Refined) alignment has been refined to improve the angle of entry into the Oxley Highway roundabout, while still maintaining the characteristics of the

alignment which were considered important during the development of the strategic designs. The refined alignment is illustrated in black in figure 8.7.



Figure 8.7: Alignment refinement of Option C (Refined)

8.3 Bridge, pavement and pedestrian / cyclist design optimisation

Following the value management workshop in which several concerns, improvements and opportunities were raised in relation to the design of the recommended Option C (Refined), further investigation was undertaken by the design team. The results of this design optimisation process have been detailed in the following sections.

Structural configuration and pier types

Based on the original cost estimates that were developed for each shortlisted option, the construction of the substructure was a significant contributor to the overall direct construction cost (approximately 25 per cent). As a result, optimisation of the structural design was considered a key component of reducing the overall cost of the project.

Pile design efficiency and bridge spans

Bridge span options were investigated at lengths of 20, 25, 30 and 35 metres to determine the most efficient structural system when considered in relation to commonly available pile sizes of nominal diameters DN900, DN1200, DN1500 and DN1800.

The analysis found a clear tipping point in the efficiency of the foundation design for spans in the 25 to 30 metres range. However, given that more overall supports would be required for the 25 metre span for the same overall structure length, the 30 metre bridge span was considered to be the optimal design to proceed with, using the arrangement of 30 metre span with five by DN1200 piles approximately 30 metres deep, subject to further design development.

Urban design consideration of this proposal has yielded concerns about the visual impact of the 'forest' of columns and this is currently under review, with a solid blade wall similar to that in figure 8.2 indicating a likely direction for the design.

Selection of pile type

As shown in Golders geotechnical report, it is evident that rock will likely be encountered on the Option C (Refined) alignment at between 24 to 32 metres depth, making bored piles relying on end bearing a viable option for this structure. Alternative piling options include precast concrete driven piles, continuous-flight auger piles or steel driven piles.

For the Gunnedah bridge, bored piles are considered the most suitable piling option. The large diameter and founding conditions make them ideally suited to carry the loads from the road bridge. In addition, construction and schedule efficiencies can be achieved due to the elimination of the need for a pile cap to tie the piles together. This will be investigated further.

Figure 8.8 illustrates this likely optimised structural cross section.

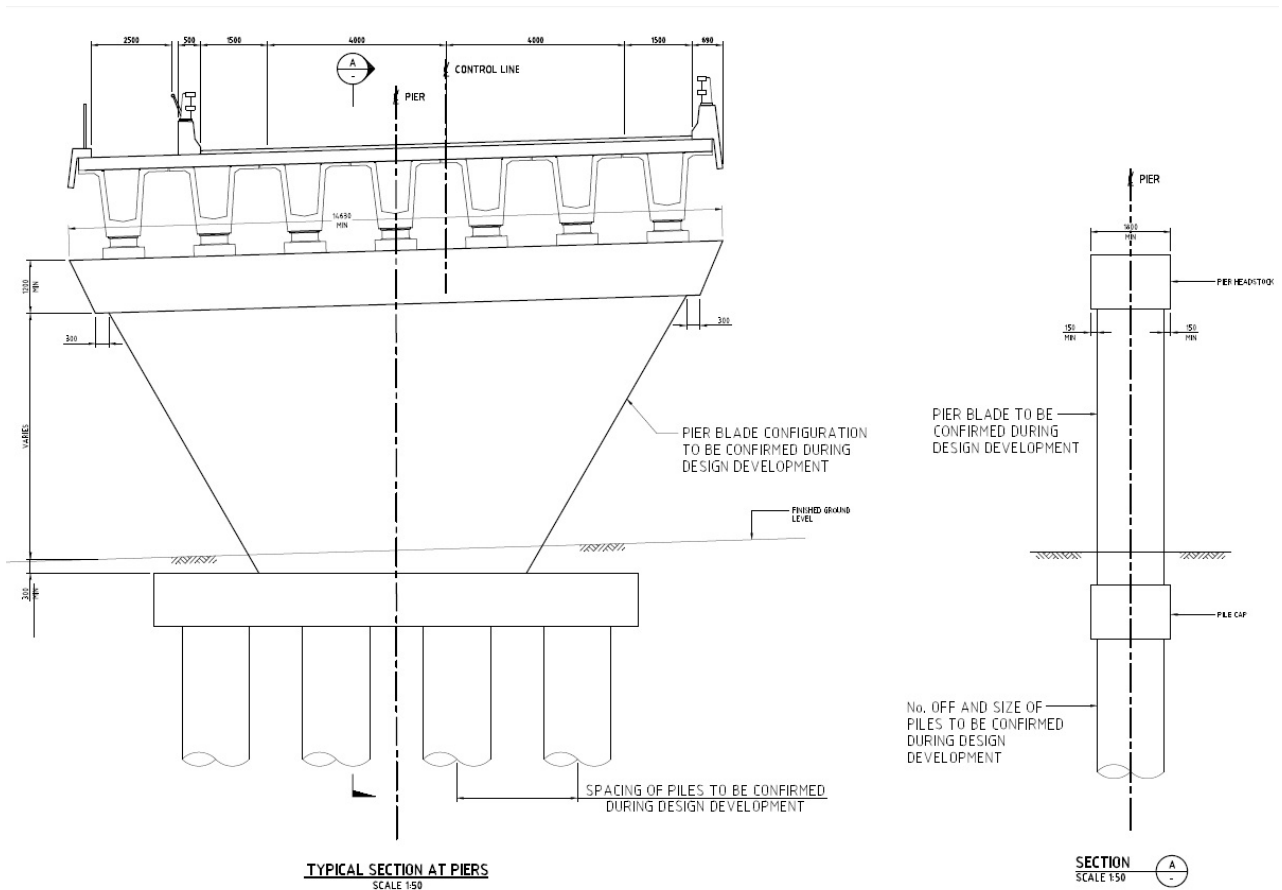


Figure 8.8: Indicative structural configuration

Pavement design

The indicative pavement design undertaken as part of the original design development process was further refined to accommodate the required traffic volumes.

The flexible pavement components were designed empirically using CIRCLY and the rigid pavement components were structurally designed in accordance with Austroads requirements. Figure 8.9 provides a detailed breakdown of the design of these two pavement systems.

As the scope of the initial geotechnical investigation did not cover specific CBR testing, these pavement designs assume an existing CBR value of five per cent is achievable across the site. This assumption will be confirmed during later stages of the design.

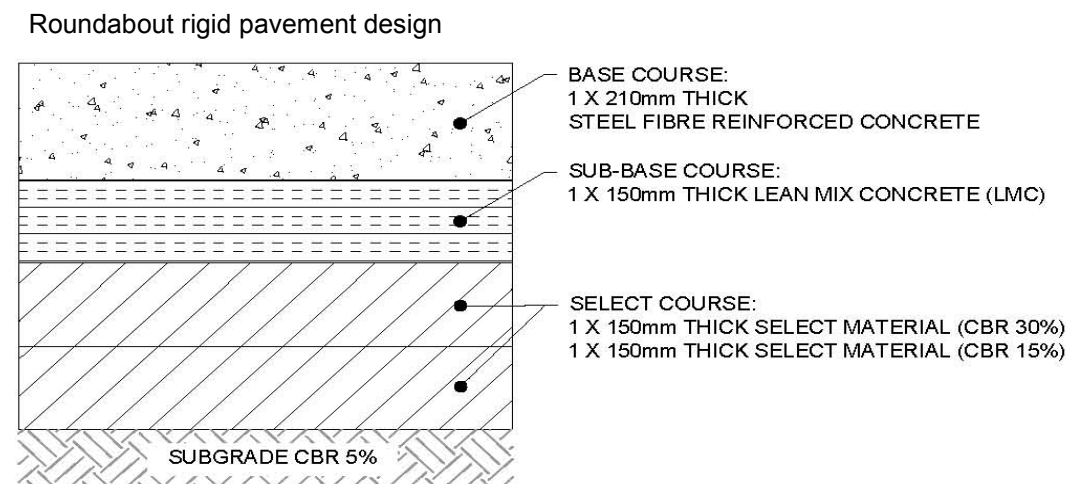
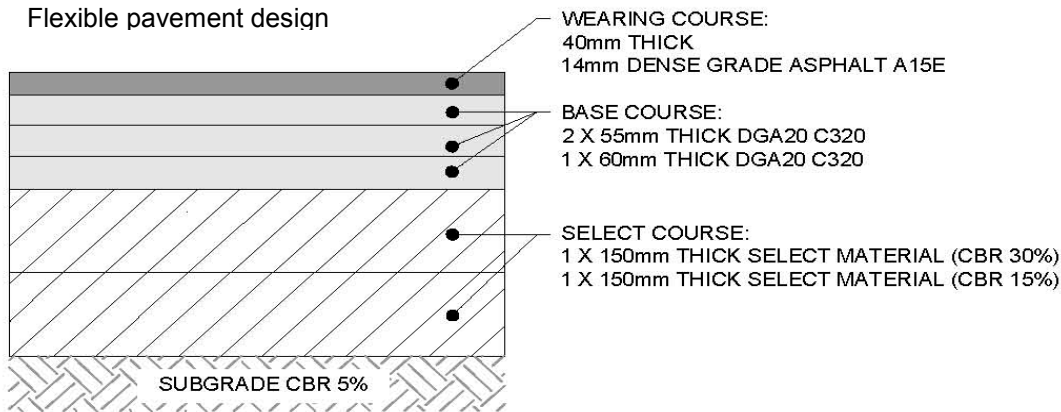


Figure 8.9: Flexible and rigid pavement design options

The transition between flexible and rigid pavements has been broken down as follows:

- Rigid pavement – the roundabouts and approaches
- Flexible pavement - the tie-ins to existing pavement and retaining wall areas.

Visual amenity / urban design

The optimisation of the recommended Option C (Refined) alignment provides several additional urban design advantages. These include:

- Slightly shifting the alignment to the east retains continuity of the arc and assists in settling the overall structure better within the floodplain setting
- The revised alignment would reduce the impact on existing vegetation, ensuring a quality buffer zone between the structure and the Mill
- The reduced size of the roundabout allows the natural setting to be more dominant and assists in receding the road elements.

The following urban design challenges are also identified which can be mitigated as part of the concept design works:

- The introduction of a row of piles without a pile cap creates a ‘forest’ of columns that compromises the appearance of the overall bridge when compared to the previously proposed ‘V’ shape piers. This negative impact can, however, be mitigated by the introduction of cladding strategies to create a single blade pier effect.

Pedestrian / cyclist provisions

Pedestrian and cycle paths will be upgraded as part of the project and a 2.5m wide shared path will be provided on the new bridge. Figure 12.1 shows their preliminary locations. Further design phases will include road safety audits and design development to determine their detailed locations.

8.4 Connectivity to Barber Street precinct

With the closure of the New Street level crossing, further investigation was undertaken to identify and assess alternative means of providing a connection to the Barber Street precinct.

Following consideration of available options, three alternatives were considered practical for providing vehicular connectivity. These are illustrated in Figure 8.10 and described below:

- Utilise the existing level crossing to maintain existing traffic flow opportunities
- Provide a direct connection from Option C (Refined) to Barber Street
- Provide no direct connection to Barber Street, but allow traffic to make a U-Turn at a roundabout on the intersection of Warrabungle Street and Kamilaroi Highway.

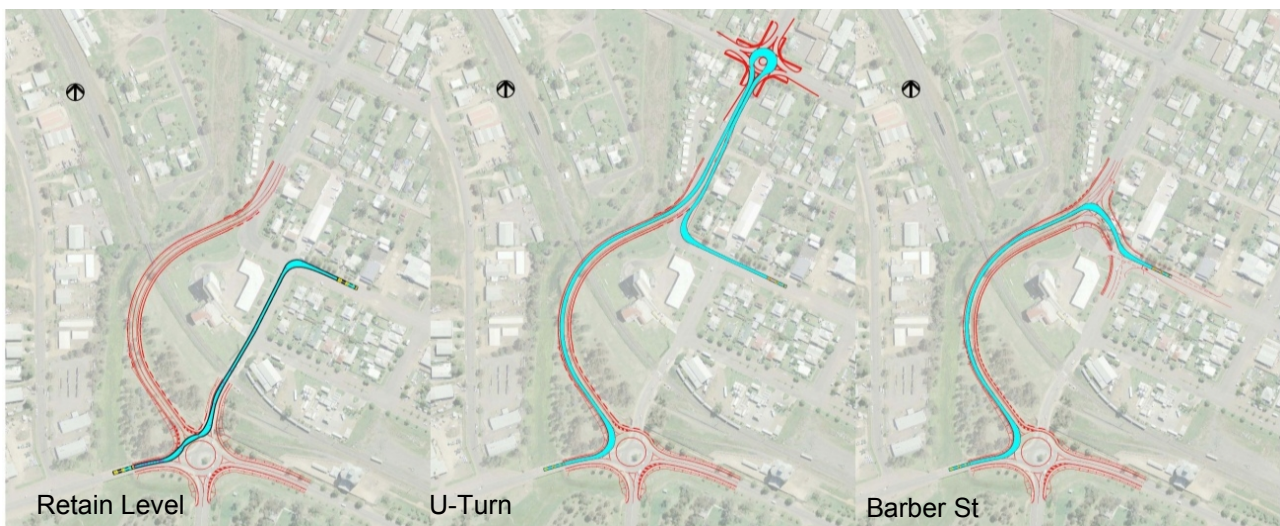


Figure 8.10: Alternatives for providing traffic connectivity to Barber Street

Constraints

There are several constraints that directly impact the ability to make a successful link to Barber Street. These include the following:

- Option C (Refined) runs immediately to the west of the Gunnedah Maize Mill. The current operation of the Mill and conditions of development consent requires the existing entry point at the corner of Warrabungle and Barber Streets to be maintained, as well as the existing exit point onto New Street
- The required single stacking clearance of the railway line equates to a height of 5.15 metres between the underside of the bridge structure and the railway line. Vertical and horizontal geometry is restricted in this location and provides design challenges for the provision of a direct Barber Street connection
- Blackjack Creek runs immediately west of the proposed alignment for Option C (Refined). Significant modifications to the alignment that increases the impact on this waterway will have a potential effect on the environmental impacts, flooding and visual amenity of the bridge and are to be avoided.

New Street level crossing

The existing level crossing at New Street provides one of three direct links to the Gunnedah town centre from the southern side of the rail line. The others are the level crossing at Marquis Street and the grade separated crossing at Abbott Street, as shown in figure 8.11 below.



Figure 8.11: Existing railway level crossing locations

The existing level crossing at New Street provides a link to the Gunnedah Town Centre via Barber Street and Warrabungle Street. The average daily traffic figures based on recent traffic counts are summarised in table 8.4.

Table 8.4: Existing Level Crossing Traffic Volumes

Item	New Street	Marquis Street	Abbott Street
Average Daily Vehicular Traffic	4,911	5,116	6,565

To accommodate the retention of the existing level crossing, the current configuration for Option C (Refined) utilised a five leg roundabout as shown in figure 8.10. The movement of southbound vehicles from the proposed bridge wishing to make a sharp turn north onto New Street will be restricted due to the entry angle of the bridge. Upgrades to signage and construction of boom gates would be required if the crossing is retained for vehicles.

U-turn Kamlaroi Highway roundabout

The existing intersection at Warrabungle Street and Kamlaroi Highway provides a give way intersection with travel priority given to the traffic on the Kamlaroi Highway.

Figure 8.12 below illustrates the proposed configuration which provides a roundabout upgrade to this intersection.



Figure 8.12: Proposed intersection upgrade – Conadilly Street / Kamilaroi Hwy / Warrabungle Street

Barber Street direct connection (tee intersection)

A direct connection to Barber Street was investigated utilising the proposed Option C (Refined) alignment, with the intersection point shifted marginally north to make an at-grade connection.

Although the Warrabungle/Barber Street intersection has significant constraints, the design team has produced the following design that provides for B-Double access to and from Barber Street as well as access to the Gunnedah Maize Mill.

The limiting design constraint is the 10 per cent maximum design grade for the northern approach to the rail overpass from the Option C(Refined) alignment. This grade dictates where the intersection point is located, which in turn determines the extent of property acquisition.

The intersection is shown in figure 8.13 below.



Figure 8.13: Proposed intersection upgrade – Barber Street

Assessment of feasible options

A detailed assessment of the positive and negative aspects of each of the feasible connectivity alternatives was undertaken to inform the decision on the most appropriate way forward. The results of this assessment, which include consideration of road safety implications, are detailed in table 8.5 on the following page and are summarised for each location below.

Table 8.5: Assessment of connectivity alternatives

Connectivity Options	Positive impacts	Negative impacts
Level crossing closed	Improves traffic safety Eliminates risk of vehicle/train collision	Reduces access to the Barber Street business precinct.
Barber Street direct connection (tee intersection)	Provides access to Barber Street precinct	Additional project costs Increased property acquisition

Business impact assessment

The community consultation process outlined in section 4 identified concerns from some sections of the local business community, Gunnedah Shire Council, the local community and representations from the Local Member regarding the potential negative effect on the Barber Street precinct businesses should the level crossing become closed to vehicles and a direct connection to Barber Street not be provided as part of the project.

Specifically, concerns were expressed about how this outcome might affect businesses located close to the level crossing, especially in Barber Street, New Street and Railway Street.

In order to better understand the potential impact, an economic business impact assessment was undertaken to assess implications for businesses should this scenario be realised.

The objectives of this economic assessment were:

- To identify and quantify business impacts likely to arise should the New Street level crossing be closed without an alternative direct access being provided to Barber Street from the new bridge.
- To provide an assessment of these retail business impacts in a 'whole-of-economy' Gunnedah context.

The areas considered as part of this economic assessment have been illustrated in figure 8.14.

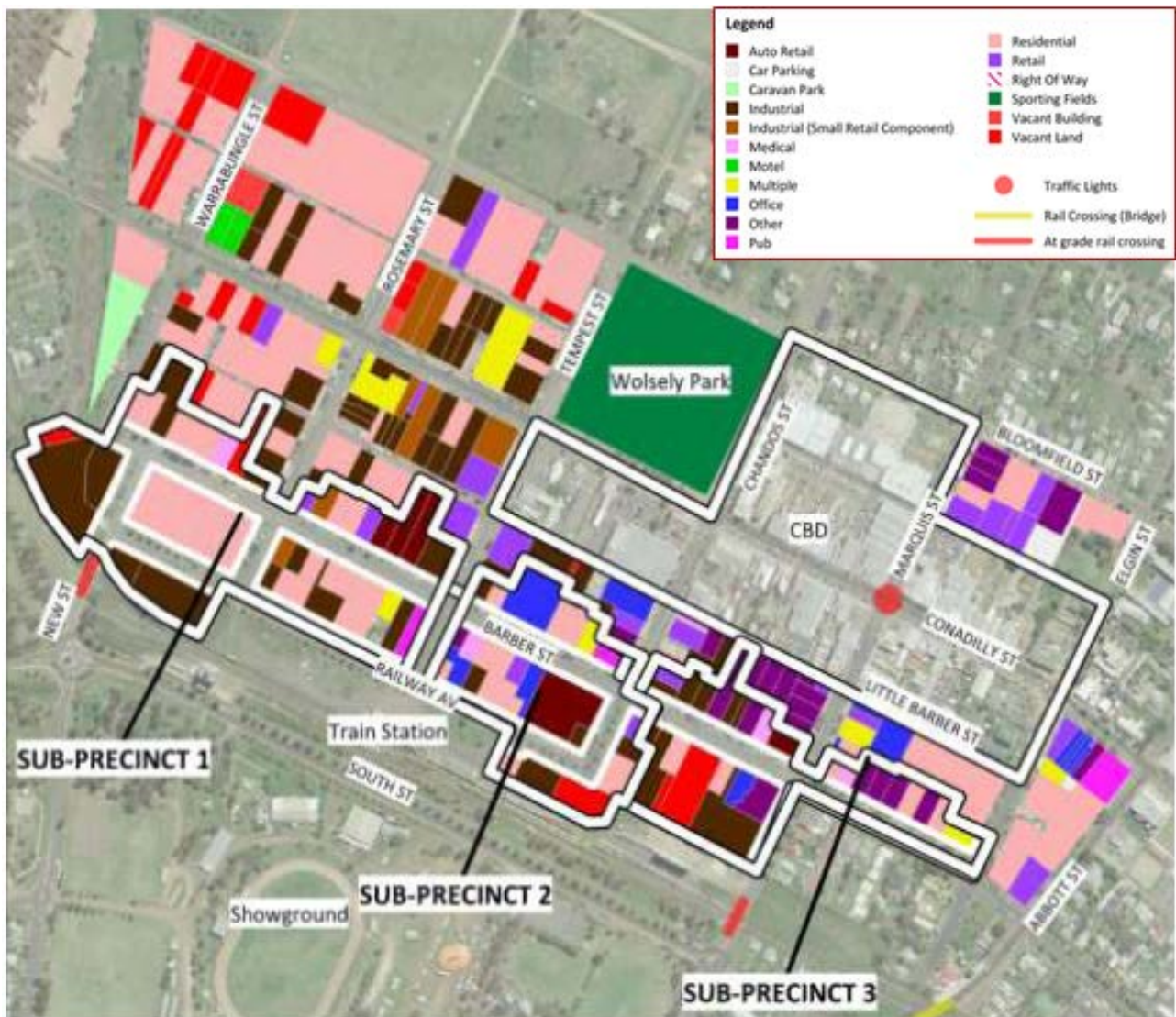


Figure 8.14: Barber Street precincts

The business impact assessment indicates there is a potential moderate loss of local passing trade in the Barber Street Precinct (estimated at about 0.9 per cent of total retail turnover in Gunnedah's Town Centre).

This lost revenue due to the crossing closure and the introduction of the Warrabungle Street bridge connection would be expected to be redirected to other parts of Gunnedah, such as the Central Business District. People would be reasonably expected to continue to undertake their household and business purchases locally, and not travel to other, more distant towns.

The provision of roundabouts at each end of the recommended option together with the connection to Barber Street will provide uninterrupted traffic access between the residential and commercial areas of Gunnedah. Roads and Maritime recognises there will be some changes to traffic patterns as a result of the project and is committed to working with Gunnedah Shire Council to develop a detailed signage plan for the project.

9 Revised MCA assessment

9.1 Overview and basis for re-assessment

The closure of the New Street level crossing to vehicular traffic will alter one of the key characteristics of the recommended Option C (Refined).

Several of the criteria that formed part of the original MCA process assessed Option C (Refined) under the assumption that the level crossing would remain open. In order to understand the potential impacts that this closure may have on the recommended option, the project team determined that a selective re-assessment of Option C (Refined) was appropriate.

The MCA criteria in which the relative performance of Option C (Refined) differs compared with the other options have been reassessed in light of the changes that would be made to the design should the New Street level crossing close. The specific criteria revisited as part of this process are outlined below:

- Traffic, transport and safety
 - Vehicle and road safety
 - Traffic flow and connectivity
 - Pedestrian and cyclist access
 - HML network efficiency
- Natural environment
 - Flooding and drainage
- Built and cultural environment
 - Community and business impacts.

Criteria in which the original assessment scores were likely to change consistently across each option, such as the cost savings associated with design optimisation, have not been reassessed as their relative performance will be the same.

9.2 Revised traffic, transport and safety assessment

The closure of the level crossing for Option C (Refined) forces vehicular traffic to behave in essentially the same manner as for Option B. Although the alignments between Option B and Option C (Refined) differ slightly in terms of the path they travel, the key features of each option are now essentially the same.

The scoring for Option C (Refined) has therefore been revised to match the original MCA assessment scores for Option B, as there is no tangible difference between the two from a traffic and road safety perspective. Table 9.1 summarises the revised assessment scores.

Table 9.1: Summary of revised traffic, transport and safety assessment

Criteria	Weighted Score	Option C (Refined)
		Single
Vehicle and road safety	/ 10.5	6.3
Traffic flow and connectivity	/ 9	7.2
Pedestrian and cyclist access	/ 7.5	4.5
HML network efficiency	/ 3	2.1

9.3 Revised flooding and drainage assessment

Flooding and drainage

Following the original MCA assessment and modifications to the Option C (Refined) alignment, the flood model was further refined to improve the representation of the flooding impacts across the entire floodplain.

The revised hydraulic modelling results show that the flood impact varies in relation to the location within the floodplain. To accommodate this, the results for afflux and velocity have been presented for two critical locations, being:

- Peak afflux and velocity at the upstream embankment, which reflects the localised worst case results within the floodplain
- Peak afflux and velocity at the bridge piers, which reflects the worst case results that are representative across the entire floodplain.

This distinction is important as it provides a more accurate overall picture of the flooding implications of construction of the proposed bridge. Table 9.2 summarises the results of the revised flood modelling works for 100 year ARI.

Table 9.2: Flood modelling results

Option	Pier afflux	Embankment afflux	Pier velocity	Embankment velocity
Option B (single stacking)	10	20	1.01	1.54
Option C (Refined) (single stacking)	7	40	1.02	1.43

The results indicate that the general flooding impact for both Option B and Option C (Refined) is minor, given that afflux values are no greater than 10 millimetres. This is due in part to the viaduct

approaches with long spans between piers, meaning the extent of obstruction adjacent to the creeks is minimised.

However, the localised afflux values in the vicinity of the embankments near the Oxley Highway are more significant. The encroachment into the floodplain is greater for Option C (Refined) as it is situated closer to the concrete dish drain.

Revised flooding assessment

To account for the greater detail presented in the afflux modelling results, an additional criteria has been added to allow distinction between the readings observed at the piers and those at the embankments. The results of the revised assessment are presented in table 9.3.

For the assessment process, each option is scored on a linear scale based on the afflux observed. An afflux of 0 represents a 100 per cent score, where the adopted maximum allowable afflux of 50 millimetres would represent a 0 per cent score.

Table 9.3: Summary of revised flooding and drainage assessment

Objective	Score	Option B	Option C (Refined)
		Single	Single
Afflux at piers	/ 7.5	6.0	6.5
Afflux at upstream embankment	/ 7.5	4.5	1.5
Impact on minor reaches	/ 5	3.5	3.5
Potential for scour and erosion	/ 5	3.5	3.5
Assessment Score	/ 25	17.5	15.0
Assessment Score	/ 100	70.0	60.0
Weighted Score	/ 3.75	2.6	2.3

9.4 Revised MCA results

Table 9.4 on the following page provides a summary of the revised MCA assessment based on the assumption that the New Street level crossing is closed to vehicular traffic.

Based on this assessment, Option C (Refined) remains the recommended option, although the difference in scoring between Option B and Option C (Refined) is less with the level crossing closed.

Based on this revised assessment, it is recommended that Option C (Refined) be endorsed as the recommended alignment, irrespective of whether the level crossing is to be closed or left open to vehicles.

Table 9.4: Revised MCA scoring results

Assessment Category	Engineering		Traffic, Transport & Safety				Natural Environment			Built / Cultural Environment			Value		
Overall Assessment Weighting	10		30				15			25			20		
MCA Assessment Criteria	Design Performance	Constructability & Staging	Vehicle & Road Safety	Traffic Flow & Connectivity	Pedestrian & Cyclist Access	HML Network Efficiency	Ecology	Flooding & Drainage	Noise & Air Quality	Heritage	Visual Amenity / Urban Design	Community & Business Impacts	Capital Cost	Lifecycle Costs & Benefits	Totals
Itemised Weighted Criteria	6	4	10.5	9	7.5	3	7.5	3.75	3.75	3.75	8.75	12.5	13	7	100
Option A (Single Stacking)	Discontinued following VMS workshop														
Option A (Double Stacking)	Discontinued following VMS workshop														
Option B (Single Stacking)	5.1	2.1	6.3	7.2	4.5	2.1	5.6	2.6	2.2	2.0	3.3	7.6	9.1	1.5	61.2
Option B (Double Stacking)	Discontinued following VMS workshop														
Option C (Refined) (Single Stacking)	5.4	2.2	6.3	7.2	4.5	2.1	5.5	2.3	2.3	2.7	6.8	8.4	8.3	1.4	65.4
Option C (Refined) (Double Stacking)	Discontinued following VMS workshop														

10 Updated risk-based cost estimate

10.1 Overview and process

Following the refinement and optimisation of several elements of the Option C (Refined) alignment, the capital cost estimate prepared as part of the original MCA assessment was updated in accordance with the Roads and Maritime Estimating Manual.

A risk workshop was undertaken in November 2013 by members of the project team to assess the planned and unplanned risks associated with the project in order to add greater governance around the contingency percentage being applied to project costs.

The outcomes of the workshop were incorporated into a risk simulation tool to produce probabilistic estimates with confidence levels of P50 and P90 for the recommended Option C (Refined). The P50 estimate denotes a value based on a 50 per cent probability that the actual cost will not exceed. Likewise, the P90 estimate denotes a value that has a 90 per cent probability of not being exceeded.

10.2 Risk-based cost estimate results

The results of the risk-based estimating process are summarised in table 10.1 below.

Table 10.1: P50 and P90 cost estimates

Description	Option C (Refined) (Single stacking)
Total Strategic Estimate (Excluding Contingency)	\$ 27M
Total Strategic Estimate (Including P50 Contingency)	\$ 30M
Total Strategic Estimate (Including P90 Contingency)	\$ 32M

11 HML route through Gunnedah

Higher Mass Limit (HML) Vehicles are vehicles that have an allowance to carry heavier loads. These vehicles have the same configuration as Restricted Access Vehicles, such as B-Doubles.

Currently there is no HML continuity through Gunnedah due to restricted access over the Abbott Street Bridge (Oxley Highway) and through Conadilly Street (Kamilaroi Highway), Gunnedah's main street (see figure 11.1 below).

The current heavy vehicle bypass route, via Bloomfield Street, caters for heavy vehicles passing through the town and Gunnedah Shire Council is committed to the ongoing upgrading and maintenance of this route. The route is a Local Road and is the responsibility of Council.

To meet the project objective to provide HML continuity through Gunnedah, Roads and Maritime and Gunnedah Shire Council are progressing a road reclassification agreement as part of the project.

The current Restricted Access Vehicle and Higher Mass Limit Vehicle maps for Gunnedah are shown in Figures 11.1 and 11.2 below.

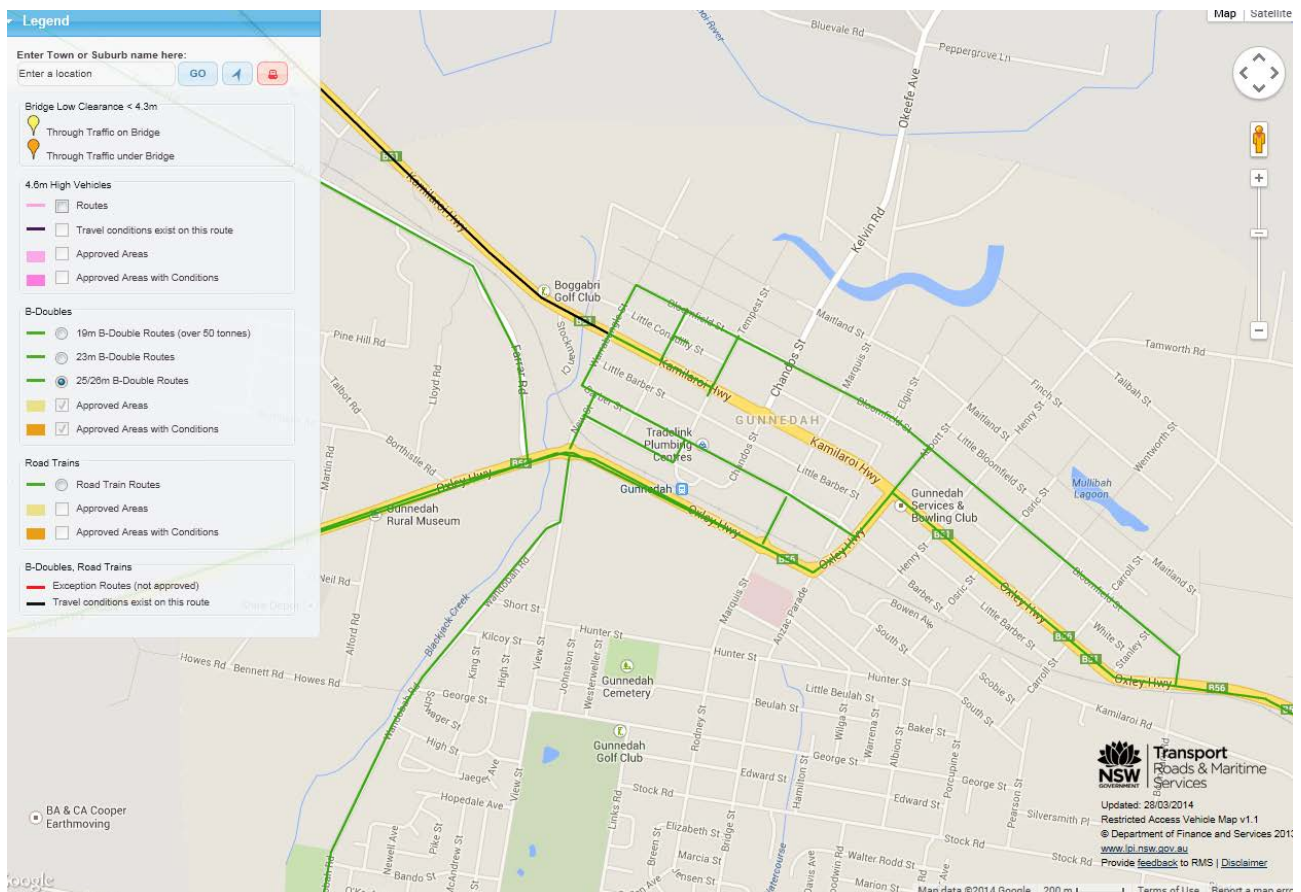


Figure 11.1: Restricted Access Vehicle map for Gunnedah

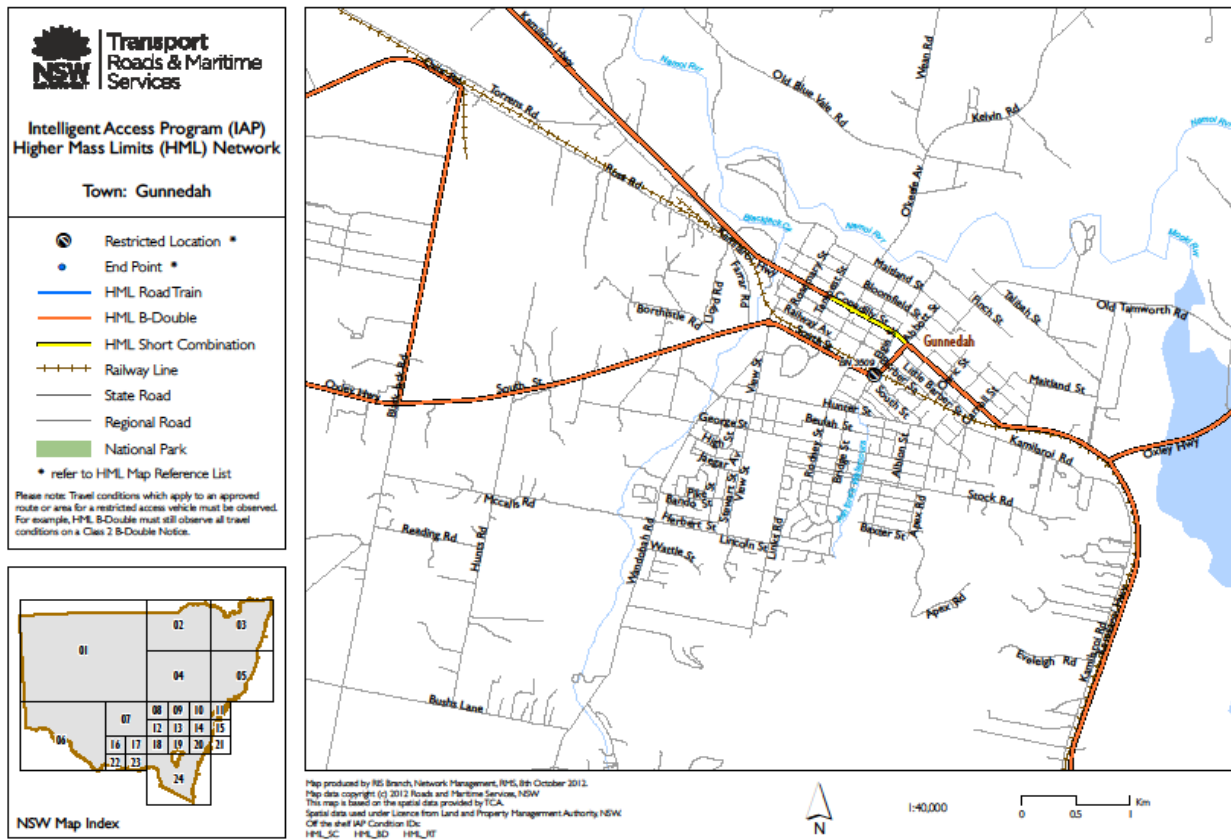


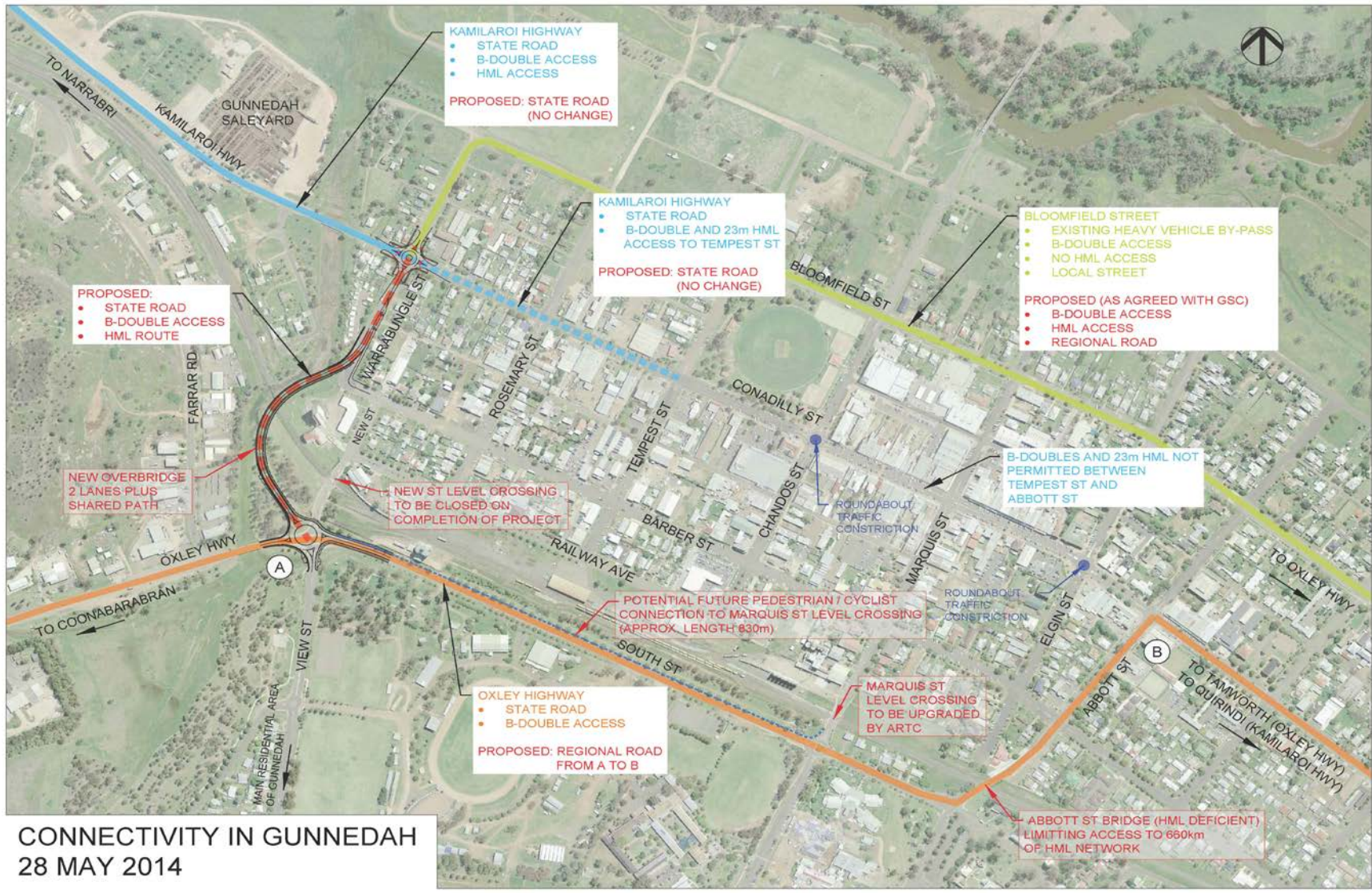
Figure 11.2: HML Vehicle Map for Gunnedah

A key outcome would be that the connecting route via Bloomfield Street, which is the current heavy vehicle bypass, will be classified as a Regional Road. This will enable Council to receive funding towards the ongoing maintenance of the route through the Regional Road Block Grants, and the Roads and Maritime REPAIR funding program.

The State Road status will remain for Conadilly Street, however this would revert from being part of the Kamilaroi Highway, to becoming part of the Oxley Highway. The current route of the Oxley Highway from Conadilly Street via South Street to View Street will become a Regional Road.

The recommended option – Option C (Refined) from the Oxley Highway via Warrabungle Street to Conadilly Street (Kamilaroi Highway) will become a State Road. This will provide a new link between the Oxley and Kamilaroi highways.

These road classifications (see figure 5.3) have been agreed and are to be formalised by Roads and Maritime and Gunnedah Shire Council (figure 11.3).



CONNECTIVITY IN GUNNEDAH
28 MAY 2014

Figure 11.3: HML route and road classifications

12 Recommended option

The results of the technical assessment, the outcomes of a value management workshop and community and stakeholders input were all considered in the identification of the recommended option, being the single stacking configuration of Option C (Refined).

The recommended option replaces the New Street level crossing which will be closed to vehicular traffic, pedestrians and cyclists when the new bridge is open to traffic and includes the intersection that connects Barber Street to the Option C(refined) alignment (see figure 12.1).

The recommended option meets the key project objectives as it will:

- Facilitate HML access through Gunnedah
- Significantly improve vehicle, pedestrian and cyclist traffic safety
- Provide uninterrupted access to the Barber Street precinct minimising the business impact
- Reduce the local traffic disruption due to increasing train length and frequency.

The recommended option takes into consideration the environment, community and other constraints of the study area and it:

- Minimises environmental effects by reducing the project footprint in the vicinity of the Oxley Highway and avoiding core Koala habitat in Wandobah reserve.
- Enhances the connectivity along the Blackjack Creek for koala movement through a wide bridge opening
- Minimises Blackjack Creek flooding effects by reducing construction over Blackjack Creek and the drainage channels south of the Oxley Highway.
- Optimises constructability by improving the curve of the bridge and providing greater railway clearance for the future duplicated rail line
- Maximises structural efficiency by retaining existing infrastructure including Oxley Highway roundabout, View Street connection and the culvert across Blackjack Creek
- Minimises the business impact to the Barber Street precinct

Figure 12.1 illustrates the recommended option.

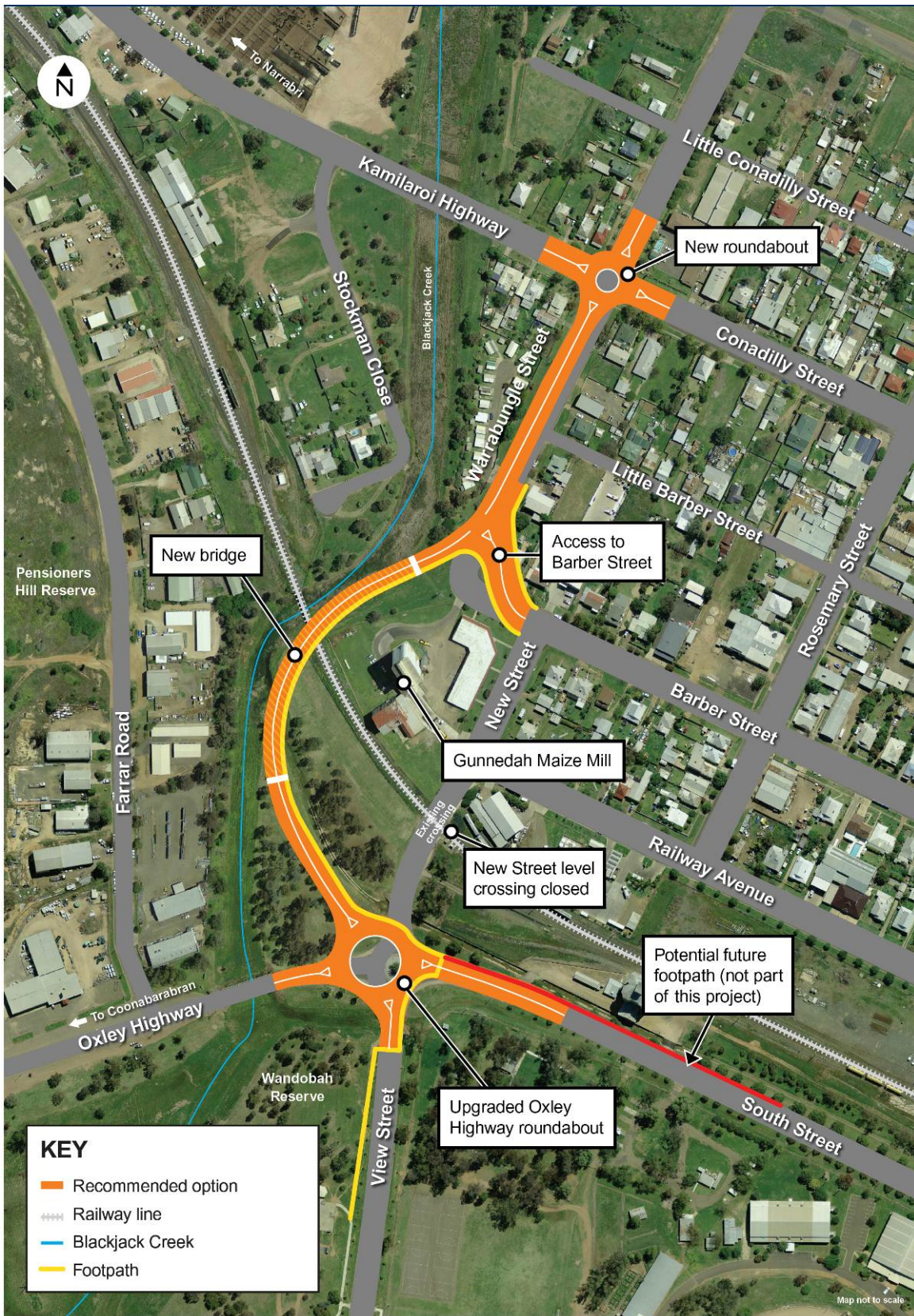


Figure 12.1: Recommended Option C (Refined)

13 Next steps

Community drop-in sessions will be held in Gunnedah to explain the recommended option and provide opportunities to discuss feedback with the project team. The comments received will be considered before a final decision is made later this year.

As part of the concept design, further field investigations will be carried out to gather information to enable this work to be completed.

The process is shown in the flowchart in figure 13.1 below.



Figure 13.1: Project development flowchart

ENDS