Key findings and outcomes
The Bells Line of Road Long Term Strategic Corridor Plan involved analyses of transport, constraint and engineering factors to identify a strategic direction for the corridor in the short, medium and long term. Key findings and Plan outcomes are listed below.

Key transport analysis findings
> The central and western sections of the Bells Line of Road are generally operating at good levels of service.
> The portion of Bells Line of Road in the vicinity of North Richmond is currently performing poorly, with high levels of traffic congestion in peak periods.
> Forecast traffic numbers based on an optimistic growth trend plus potential induced demand do not reach the levels that would trigger a need (from a traffic perspective) to upgrade the full length of Bells Line of Road to four-lanes in any foreseeable planning horizon.
> Forecast traffic numbers suggest that there may be a need to upgrade a portion of Bells Line of Road (east of approximately Kurrajong Heights) to four-lanes in the long term.

Key constraint analysis findings
> Any major road upgrade through the central and western parts of the Bells Line of Road corridor would be extremely challenging from an environmental, approvals and construction cost perspective. This area (particularly the central section) includes the Greater Blue Mountains World Heritage Area, which has a wide range of ecological and cultural values. It also coincides with challenging terrain which would be likely to add greatly to the cost of construction.

Key engineering analysis findings
> The Bells Line of Road from North Richmond to Lithgow features a wide variety of road characteristics and changing speed limits.
> There are many locations where the existing horizontal and vertical road geometry falls below current new road standards and guidelines. In particular this includes tight horizontal curves, steep grades, and sharp crest curves affecting sight distance.
> Overtaking opportunities are restricted by the horizontal and vertical geometry and there are few overtaking lanes. In particular, there is a 25 kilometre-long section between Kurrajong Heights and Mount Tomah where there is no overtaking lane in either direction.
> For most of the corridor the road cross-section is also below current standards and guidelines for the design of new sections of road. This includes lane widths, sealed shoulder widths and clear-zone widths.
> The Bells Line of Road has a poor crash record. At about 54 crashes per 100 million vehicle kilometres travelled or 21 casualty crashes per 100 million vehicle kilometres travelled, the crash rates are about twice typical rates for rural roads in NSW.

Key Plan outcomes
> A major upgrade of the entire corridor is not warranted in the foreseeable future.
> Other opportunities have been considered in previous studies, including a route across the Newnes Plateau to the north of Lithgow and routes through the Hartley Valley. These previous studies have found these routes to have limited feasibility. The analyses conducted as part of the preparation of this Plan reaffirm these outcomes, particularly in terms of environmental constraints, and they are not regarded as strategic opportunities for the purposes of corridor planning.
> The need for the reservation of an upgraded road corridor connecting the Bells Line of Road corridor at Kurrajong Heights with the Sydney motorway network is established in this Plan. The commencement of planning for the identification of a preferred route and reservation on councils’ Local Environment Plans is identified as a short term priority (0–5 years), and could be expected to continue into the medium term (5–20 years).
> Any option to connect Kurrajong Heights to the Sydney motorway network would require extensive and rigorous investigations to identify a cost effective route that efficiently negotiates the change in elevation while minimising socio-economic and environmental impacts.
> In addition to the need to reserve an upgraded road corridor between Kurrajong Heights and the Sydney motorway network, a range of other short, medium and long term improvements including safety improvements have been identified as being required to address the ongoing function and needs of the corridor.
Executive summary

Introduction
In November 2009, the Australian and NSW governments jointly announced the commencement of a Long Term Strategic Corridor Plan (the Plan) for the Bells Line of Road.

This Long Term Strategic Corridor Plan has been prepared by Roads and Maritime Services (RMS). It outlines a process to guide the development and reservation of a road corridor for a future upgraded Bells Line of Road. It also recommends measures and priorities for the short, medium and long term future development of this important road corridor.

The scope of this Plan
In March 2010, the Terms of Reference were published outlining the scope of the Plan (Appendix A). The Terms of Reference also provide a series of outputs that are to be developed through extensive community and stakeholder consultation. These are listed below, along with a reference to the section of the Plan where the outputs are included:

> Outline of the study methodology (Section 1.4).
> Summary of findings from relevant past studies pertaining to the Bells Line of Road corridor (Section 1.3).
> Forecast traffic growth along the route – 25 year horizon (Sections 4.5.3 and 4.5.4).
> Identified priorities for the development of the Bells Line of Road corridor (Chapter 8).
> Identification of broad options that meet long term corridor requirements, project objectives and project design standards (Chapter 8).
> Summary of additional work required (Chapter 9).
> Schedule of tasks for selection of a preferred corridor (Chapter 9).

> Recommended timeframe for further development (Chapter 8).
> Recommended sequencing of implementation (Chapter 8).

The Terms of Reference established that the development of the Plan was guided by a Governmental Steering Committee that consisted of representatives from the NSW Government, the Australian Government, the Central Region of Councils (Centroc) and the Western Sydney Region Organisation of Councils (WSROC).

The project area
The project investigation area for the Plan covers three sections (refer to Section 1 of the Plan for a map of the project area):

> Eastern section – Sydney motorway network to Kurrajong Heights.
> Central section – Kurrajong Heights to Bell.
> Western section – Bell to the Great Western Highway.

Corridor Objectives
RMS developed preliminary objectives for the Bells Line of Road Corridor based on key issues identified in previous studies. These preliminary objectives were presented to the community for comment and were endorsed by the Governmental Steering Committee. The Bells Line of Road Corridor Objectives are as follows:

Objective 1: Safety – improve road safety for all road users, including vehicle users, motorcyclists, pedestrians and cyclists.

Objective 2: Transport and access – provide an efficient road corridor for moving people and goods.

Objective 3: Land use development – respond to present and future land uses.

Objective 4: Environment – respect the natural and built environment and community values.
How this Plan was prepared

The Bells Line of Road Long Term Strategic Corridor Plan has been prepared by integrating community consultation with three streams of technical analysis covering engineering, transport and constraint analysis. A short summary of the key findings from the community consultation process and each of the technical streams follows. For more detail regarding outcomes of community consultation, refer to the Community Issues Report, June 2012, which is posted on the project website www.rms.nsw.gov.au/roadprojects

Community consultation findings

Community involvement has been integral to the development of the Plan. From 1 November 2010 to 31 January 2011, RMS conducted an extensive community involvement process. The high level of input provides valuable insights into how the community perceives the future of the road, and shows that the road is of interest to the communities it connects as well as the community that lives along it.

Key issues raised during community consultation include:

Safety – the general condition and safety of the road, including alignment, road surface and width, intersections and visibility.

Traffic and access – the amount and type of traffic; and increased congestion in the eastern section.

Environmental impacts – potential impacts on flora and fauna, endangered ecological communities and the Greater Blue Mountains World Heritage Area, as well as potential impacts on tourist and recreational amenity.

Regional and local economies – there is strong support from stakeholders in central and western NSW for improved access through a major upgrade of the route.

RMS has used the findings of the community involvement process to inform technical studies and help identify broad strategic opportunities for upgrading the corridor (refer to sections 4, 5 and 6).

Transport analysis findings

The transport analysis considered the current and future transport needs for the Bells Line of Road corridor, taking into account population and traffic forecasts, and the desired ‘level of service’ of the road. The analysis considered traffic that may be attracted to the corridor if a major corridor upgrade was undertaken.

The transport analysis of the Bells Line of Road corridor found that:

> Long term traffic growth rates on the Bells Line of Road have generally been below 1.0 per cent per annum. Growth rates have picked up since 2005, but have generally remained below 1.5 per cent per annum. Traffic growth rates on the Great Western Highway to the west of the Darling Causeway have been stronger than on the Bells Line of Road.

> The central and western sections of the Bells Line of Road are generally operating at good levels of service.

> The portion of Bells Line of Road in the vicinity of North Richmond is currently performing poorly, with high levels of traffic congestion in peak periods.

> Forecast traffic numbers based on an optimistic growth trend do not reach the levels that would trigger a need to upgrade the full length of Bells Line of Road to four-lanes in any foreseeable planning horizon.

> Forecast traffic numbers based on an optimistic growth trend plus potential induced demand also do not reach the levels that would trigger a need to upgrade the full length of Bells Line of Road to four-lanes in any foreseeable planning horizon.

> Forecast traffic numbers suggest that there may be a need to upgrade a portion of Bells Line of Road (east of approximately Kurrajong Heights) to four-lanes in the long term.
Constraints analysis findings
The constraints analysis assessed existing conditions within the Bells Line of Road corridor that may influence the location and nature of future road improvements in the short, medium and long term.

The constraints analysis confirmed and reiterated previous findings that:

> Any major road upgrade through the central and western parts of the Bells Line of Road corridor would be extremely challenging from an environmental, approvals and cost perspective.

> This corridor includes the Greater Blue Mountain World Heritage area which has a wide range of ecological and cultural values. It also coincides with challenging terrain which would be likely to add greatly to the cost of construction. Any major road upgrade through this area would require very strong justification in terms of community need and economic benefit to counter the potential environmental and social impacts.

> There are more opportunities for new road development in the eastern section than in the central and western sections. In this section there are areas of lower environmental value and terrain that is generally more conducive to road construction.

> One major challenge in the eastern section is increasing urbanisation in western Sydney, which will gradually increase the level of constraint to new road development. Early planning for any future road development in this area will maximise opportunities to integrate the road development into future urban areas.

Engineering analysis findings
The engineering analysis assessed the physical characteristics and recent crash history of the road to determine where future works or upgrades may be required in the short, medium and long term.

The engineering analysis of the Bells Line of Road found that:

> There are many locations where the existing horizontal and vertical road geometry falls below current standards and guidelines for the design of new sections of road. In particular this includes tight horizontal curves, steep grades, and sharp crest curves affecting sight distance.

> Overtaking opportunities are restricted by the horizontal and vertical geometry and there are few overtaking lanes. In particular, there is a 25 kilometre-long section between Kurrajong Heights and Mount Tomah where there is no overtaking lane in either direction.

> For most of the corridor the road cross-section is below current new road standards and guidelines. This includes lane widths, sealed shoulder widths and clear zone widths.

> With this standard of road there is less margin for error and drivers are required to concentrate more than they would on a more consistent and/or higher standard road.

> As a consequence of the above, the Bells Line of Road has a poor crash record. At about 54 crashes per 100 million vehicle kilometres travelled and 21 casualty crashes per 100 million vehicle kilometres travelled the crash rates considerably higher than the typical rates for rural roads in NSW.

> There are some sections of the Bells Line of Road where there appear to be particular problems contributing to crash rates. These are:

- Berambling to Mount Tomah Botanic Garden, which has poor geometry and a high crash rate.

- Blue Mountains National Park to Mount Wilson Road, which has poor geometry and a high crash rate.
- Mount Wilson Road to Darling Causeway at Bell, which has average geometry but a high crash rate. Speeding has been found to be a major contributing factor and many crashes occurred when it was raining.
- Zig Zag railway to Hartley Valley Way, which has poor horizontal and vertical geometry, with restricted shoulder widths.

Strategic opportunities for a major upgrade of the Bells Line of Road corridor

The projected traffic volumes, even under a high growth scenario, suggest that a major upgrade of the Bells Line of Road west of Kurrajong Heights is not justified in the foreseeable future. However, it is anticipated there will be a traffic efficiency justification for a major upgrade of the Bells Line of Road corridor east of Kurrajong Heights in the long term.

The traffic analysis shows that while traffic levels are not high, a significant proportion of traffic travels between Bells Line of Road and the Sydney motorway network. Existing congestion at North Richmond currently affects this connection at peak times, while traffic forecasts suggest that congestion may occur as far west as Kurrajong Heights in the long term if no network improvements are undertaken. Likewise, significant development pressures in north-western Sydney mean that reservation of a corridor is required in the short to medium term, with the process to reserve a corridor commencing in the short term. It is clear that the Bells Line of Road requires an effective ongoing connection to the Sydney motorway network.

Traffic at the western end of the Bells Line of Road corridor also requires an effective long term connection with the Great Western Highway. The current connection runs through the Lithgow urban area and is subject to traffic and amenity issues including speed restrictions, albeit for a relatively short distance.

Strategic opportunities for an eastern corridor upgrade

The following strategic opportunities have been identified for an upgraded Bells Line of Road corridor east of Kurrajong Heights:

- Upgrade primarily within the existing alignment, including upgrading of Richmond Bridge and its approaches, and connecting with the Blacktown Road/Richmond Road corridor, which would also be upgraded as appropriate.
- Establish a new connection between Kurrajong Heights and the Sydney motorway network which may utilise sections of the existing road network such as The Driftway, Richmond Road and/or Londonderry Road, or rely on an entirely new corridor.
- Establish a new connection that crosses the Hawkesbury (or Nepean) River further south and utilises all or part of the Castlereagh Freeway corridor to connect with the Motorway at Dean Park.

Under current RMS planning, Richmond Road is proposed to be progressively upgraded to a six lane urban arterial road as the North West Growth Centre develops. However, it is unlikely that an upgrade primarily within the existing alignment will provide an efficient long term connection between the Bells Line of Road and the Sydney motorway network, as it traverses existing and future urban areas and will continue to provide access for local traffic. Nonetheless, a future upgrade of Richmond Road may provide opportunities for short to medium term improvements to traffic congestion in the eastern corridor.

A new corridor, or a corridor that utilises parts of the existing network, is more likely to provide an efficient long term connection between Kurrajong Heights and the Sydney motorway network.

It is unlikely that traffic associated with the Bells Line of Road would in itself justify development of the Castlereagh Freeway corridor. If the Castlereagh Freeway corridor is developed for
other reasons, such as large urban releases between the North West Growth Centre and Penrith or as an alternative access route to Penrith, then a connection between the Bells Line of Road at Kurrajong and the Castlereagh Freeway corridor would potentially be viable in the long term.

Any option to connect Kurrajong Heights to the Sydney motorway network would require extensive and rigorous investigations to identify a cost-effective route that efficiently negotiates the change in elevation while minimising socio-economic and environmental impacts.

For further detail on the corridor development priorities, refer to Chapter 8 of this document.

Strategic opportunities for improved connections to the Great Western Highway (in the Lithgow area)

The following strategic opportunities have been identified for improved connections between the Bells Line of Road corridor and the Great Western Highway in the Lithgow area:

> Use the existing road corridor through Lithgow with traffic rationalisation where appropriate.
> Use the Darling Causeway to connect with the Great Western Highway at Mount Victoria, with upgrades to Darling Causeway and the Great Western Highway as appropriate.

Other opportunities have been considered in previous road planning studies, including a route across the Newnes Plateau to the north of Lithgow and routes through the Hartley Valley. These previous studies have found these routes to have limited feasibility. The analyses conducted as part of the preparation of this Plan reaffirm these outcomes, particularly in terms of environmental constraints, and these routes are not regarded as strategic opportunities for the purposes of corridor planning.

Short and medium term improvements to the existing corridor

The engineering analysis identified a number of potential short and medium term improvements to the existing corridor. These include:

> Minor realignments and straightening.
> Overtaking lanes.
> Lanes, shoulders, clear zones, safety barriers and improved drainage.
> Pedestrian and cycle access.
> Intersections.
> Driveways.
> Slope stabilisation.
> Bridge safety.
> Rest areas.
> An urban and landscape design framework.
> Environmental management.

Next steps – corridor reservation process

The need for the reservation of an upgraded road corridor connecting the Bells Line of Road corridor at Kurrajong Heights with the Sydney motorway network is established in this Plan.

The commencement of planning for the identification of a preferred route and reservation on councils’ Local Environment Plans is identified as a short term priority (0–5 years), and could be expected to continue into the medium term (5–20 years).

The construction of an upgraded corridor in the eastern section is expected to be required in the long term (20+ years). Given changing land use in western Sydney and the need to provide certainty for land owners and land use planners, the corridor needs to be identified and reserved well in advance of major construction.
The Plan also identifies that the reservation of an upgraded corridor west of Kurrajong Heights is not a priority, once considerations about land use, transport and policy are taken into account.

The process to reserve an upgraded road corridor to connect Kurrajong Heights with the Sydney motorway network is as shown in Figure i. The community and stakeholders would be involved in the process.

The additional work required to reserve an upgraded road corridor, and the timeframes for each planning phase, are as follows. It should be noted that each phase will be subject to availability of funding and there may be gaps between each phase being undertaken.

**Route options study**  
*Timeframe: 2-4 years from engagement of contractor*

The purpose of the route options study is to identify and develop feasible route options and, taking into account technical studies and community input, recommend a preferred route for an upgraded road corridor. While Kurrajong Heights and the Sydney Motorway Network have been identified as nominal extents for corridor connections, the specific connection locations would be developed and there would be some flexibility regarding the eastern and western extents of the study area.

The route options study would build on technical investigations undertaken to date and provide more refined analyses of socio-economic, environmental, cultural, and engineering considerations. A number of possible route options would be expected to be generated for community comment. Extensive community, stakeholder and agency consultation would be a fundamental component of this study, with all potentially affected landholders informed as part of the process.

**Preferred route announcement**  
*Timeframe: Following conclusion of route options study*

The decision on a preferred route is made by the NSW Minister for Roads and Ports, taking into account the recommendations of the route options study. The Minister’s decision on a preferred route would be announced to the community, and all potentially affected landholders contacted.

**Concept design**  
*Timeframe: 1-1.5 years*

Following the announcement of a preferred route, concept design for the route is undertaken in order to set property boundaries for inclusion in councils’ Local Environmental Plans as a reserved corridor. This process would involve targeted analyses of socio-economic, environmental, cultural and engineering considerations. It would also involve detailed discussion with affected landholders, agencies and other stakeholders.

**Corridor reservation**  
*Timeframe: In excess of six months, depending on status of councils’ Local Environmental Plans*

The reservation of a future upgraded road corridor can take place once the concept design has been prepared and future property boundaries established. To undertake this process, RMS would write to councils, requesting that the road corridor be included in their Local Environment Plans. Councils would then need to amend existing Local Environmental Plans or include the corridor in new Local Environmental Plans. These would undergo statutory consultation before being approved by the Minister for Planning and Infrastructure and formally gazetted. Once fully incorporated into Local Environmental Plans, the corridor would be regarded as being reserved.
Next steps – existing corridor improvement process

In addition to the need to reserve a corridor for an upgraded (four-lane) Bells Line of Road between Kurrajong Heights and the Sydney motorway network, a range of other short, medium and long term improvements have been identified as being required to address the ongoing function and needs of the corridor. The additional work required to provide these improvements comprises a series of technical investigations to identify a schedule of improvements that address the needs of the corridor and best represent value for money.

These investigations are described individually below, but may be undertaken concurrently or in an integrated fashion.

Safety review

*Timeframe: 6–12 months*

A safety review is required to:

> Provide a detailed list and description of safety issues within the corridor.
> Evaluate potential measures to address the safety issues in terms of effectiveness, cost and environmental impact.
> Identify preferred safety measures in order of priority at a level of detail that will allow incorporation of measures into RMS budget and planning processes.

Overtaking lane review

*Timeframe: 6–12 months*

An overtaking review is required to:

> Provide a detailed assessment of the adequacy of existing overtaking lanes, including length, geometry, line-marking and signage.
> Identify specific locations (including lengths) for additional overtaking lanes at a level of detail that will allow incorporation into RMS budget and planning processes. This includes identification of overtaking lanes between Kurrajong and Mount Tomah that are a short term development priority.
> Identify improvements required to existing overtaking lanes.
> Identify priorities for the implementation of new and improved overtaking lanes.

Intersections review

*Timeframe: 6–12 months*

An intersections review is required to:

> Provide a detailed evaluation of intersections within the corridor in terms of safety and transport efficiency.
> Identify the types of improvements that may be implemented to improve intersection performance and safety (including improved sight lines, additional turning lanes and staged crossings).
> Identify improvements at a level of detail that will allow incorporation into RMS budget and planning processes.
> Identify priorities for the implementation of intersection improvements.

Access review

*Timeframe: 6–12 months*

An access review is required to:

> Provide a detailed assessment of access characteristics within the corridor, identifying particular safety and transport efficiency issues.
> Identify opportunities to address safety-related access issues within the corridor.
> Outline a program to improve access arrangements at a level of detail that will allow incorporation into RMS budget and planning processes.
> Identify priorities for the implementation of access improvements.

**Richmond Bridge and approaches congestion study**

The Richmond Bridge and approaches congestion study is investigating options that would assist in alleviating traffic congestion at North Richmond. The study is being carried out in two stages:

The Stage 1 study includes:

> Analysing the current traffic situation in order to identify potential short and medium term solutions.
> Investigating the structural suitability of the existing bridge for upgrade or widening.

The Stage 2 study includes:

> Developing of strategic concept design options for Richmond Bridge and approach roads between Richmond and North Richmond for a longer term solution.

**Plan review**

This Plan may be reviewed and updated in response to changing transport network characteristics, government policy and/or community values.

Any review of the Plan would require appropriate consultation with the community, as well as updating of technical inputs to the Plan.
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Bells Line of Road Long Term Strategic Corridor Plan

Part A - Preliminary
1 Introduction

This chapter explains why and how this Plan has been prepared, summarises the scope of the Plan, and introduces the project investigation area.

1.1 The Bells Line of Road

The Bells Line of Road (State Route 40) is an important road linking north-western Sydney with central and western New South Wales. It runs from North Richmond in the east to the intersection with the Darling Causeway at Bell in the west. The road is one of two road crossings of the Blue Mountains; the other is the Great Western Highway.

The Bells Line of Road was originally known as Bells Line, after a local pastoralist, Archibald Bell Jr, who was shown the route by Dharug men in 1823.

The Great Western Highway has historically been (and remains) the primary route across the Blue Mountains, attracting the majority of cross-mountain traffic. Bells Line of Road performs a secondary role for cross-mountain traffic and is also used as a local access road.

In this report, the Bells Line of Road ‘corridor’ refers to the Bells Line of Road as well as associated connections to the Sydney motorway network and the Great Western Highway.

1.2 Scope of this Plan

In November 2009, the Australian and NSW governments jointly announced the commencement of a Long Term Strategic Corridor Plan (the Plan) for the Bells Line of Road.

In March 2010, the Terms of Reference were released for the Plan (Appendix A). The Terms of Reference state that the Plan “will guide the development and reservation of a road corridor for a future upgraded Bells Line of Road. Although current projections indicate that a major upgrade of Bells Line of Road is not expected to be required until at least 2033, it is appropriate that planning for this corridor progresses now for the future.”

The Terms of Reference also identified a series of outputs to be included in the Plan that are to be developed through extensive community and stakeholder consultation. These are listed below, along with a reference to the section of the Plan where the outputs are included:

> Outline of the study methodology (Section 1.4).
> Summary of findings from relevant past studies pertaining to the Bells Line of Road corridor (Section 1.3).
> Forecast traffic growth along the route – 25 year horizon (Sections 4.5.3 and 4.5.4).
> Identified priorities for the development of the Bells Line of Road corridor (Chapter 8).
> Identification of broad options that meet long term corridor requirements, project objectives and project design standards (Chapter 8).
> Summary of additional work required (Chapter 9).
> Schedule of tasks for selection of a preferred corridor (Chapter 9).
> Recommended timeframe for further development (Chapter 8).
> Recommended sequencing of implementation (Chapter 8).

The Terms of Reference also established a governance structure to guide the preparation of the Plan. This included a Governmental Steering Committee comprising representatives of all levels of government, specifically:

> Commonwealth Department of Infrastructure and Transport.
> New South Wales Department of Premier and Cabinet.
1.3 Previous studies

A number of previous studies have considered the need for an upgrade to the Bells Line of Road, particularly the Central West Transport Needs Study (2009) and the Bells Line of Road Corridor Study (2004). These studies have generally concluded that a major upgrade of the Bells Line of Road corridor is not justified on economic, social and environmental grounds within the planning horizons that were evaluated.

Previous reports have however suggested that interim improvements to the corridor may be required. They have also identified that consideration should be given to reserving a corridor to enable future connections to Sydney’s motorway network and the Great Western Highway.

For more detail on previous reports, refer to Background Summary and Corridor Objectives Report, November 2010. This report, as well as previous reports, are posted on the project website, www.rms.nsw.gov.au/roadprojects.

1.4 How this Plan was prepared

This Plan has been prepared by integrating community consultation and strategic technical investigations covering engineering, transport and constraint analysis (Figure 1.1). This in turn has drawn on a range of previous studies undertaken in relation to the corridor (refer to the Background Summary and Corridor Objectives Report, November 2010, for a summary of previous studies).
Transport analysis
The transport analysis provides an assessment of the corridor’s existing and future capacity and efficiency. The analysis helped to identify when upgrades may be required in the short, medium and long term, and the potential locations of these improvements. (Refer to Chapter 4 and the Transport Analysis Technical Paper).

Constraint analysis
The constraint analysis provides an assessment of environmental, social and physical constraints within the corridor, and maps the locations of sensitive issues. It helps identify the feasibility of future upgrades and provides a tool for more detailed corridor planning after the completion of the Plan. (Refer to Chapter 5.)

Engineering analysis
The engineering analysis provides an assessment of the current condition of the road network and road safety in the Bells Line of Road corridor and how these could be improved. (Refer to Chapter 6 and the Crash Analysis Technical Paper).

Plan outcomes
Outcomes of the plan are described in Chapter 8, 9 and 10. These chapters bring together the findings of the four streams described above to identify the opportunities for corridor improvements (including the process associated with the reservation of a new corridor), corridor development priorities (in the short, medium and long term) and the steps that need to be taken to achieve the identified development priorities.

1.5 The project area
The project investigation area for the Plan covers three sections (Figure 1.2). The three sections have been identified on the basis of environmental character and corridor planning challenges.

Eastern section – Sydney motorway network to Kurrajong Heights
The eastern section comprises the area between the Sydney motorway network and Kurrajong Heights. It includes much of Sydney’s North West Sector, Richmond and North Richmond, and encompasses the M7 Motorway and the existing reservation for the Castlereagh Freeway and Windsor Road. The project area does not include the M4 motorway as it is not considered likely that there would be feasible direct connections between Bells Line of Road and the M4 motorway.

This section represents a transition between the rapidly changing urban fringe of north-western Sydney and the rural and bushland environment of the lower Bells Line of Road.

Central section – Kurrajong Heights to Bell
The central section covers the majority of the Bells Line of Road. This section is characterised by a rural setting in the east, which gives way to the natural bushland and rugged terrain associated with the Blue Mountains National Park and the Greater Blue Mountains World Heritage Area.

Western section – Bell to the Great Western Highway
The western section incorporates a wide area to the west of the Bells Line of Road that will allow for identification of the most appropriate connection between the Bells Line of Road and the Great Western Highway. This section is generally bounded by Darling Causeway in the east, Chifley Road and Marrangaroo in the north, and the Great Western Highway in the south. It comprises a mix of agricultural land and bushland (mostly within national park and state forest), mining, and the city of Lithgow.
Figure 1.2 Project area
Part B – Inputs to the Plan
2 Corridor Objectives

This chapter provides an overview of the objectives for the Bells Line of Road corridor and explains how these objectives are addressed in the Plan.

To set objectives for the Bells Line of Road corridor, Preliminary Objectives were first developed based on key issues identified in previous reports (refer to the Background Summary and Corridor Objectives Report, October 2010 – available on the project website www.rms.nsw.gov.au/roadprojects). These Preliminary Objectives were then presented to the community for comment through the community involvement described in Chapter 3. While there was much community comment and input regarding how these objectives could be put into practice, general feedback was that the Preliminary Objectives were appropriate to be carried forward (refer to the Community Issues Report, June 2012, available on the project website, www.rms.nsw.gov.au/roadprojects for more detail). The Corridor Objectives are described below along with the ways that these have been addressed in the preparation of the Plan:

> Objective 1: Safety – improve road safety for all road users, including vehicle users, motorcyclists, pedestrians and cyclists.

Road safety is a primary objective of any RMS road project. To address this Objective, the Plan:

> Reviews crash statistics on the Bells Line of Road corridor, as well as the existing corridor conditions, to identify trends and any areas of concern (Chapter 6).
> Evaluates the existing corridor to identify the types and general locations of potential safety improvements that may require further investigation (Chapters 6, 7 and 8).
> Recommends an approach to short, medium and long term safety improvements (Chapters 8 and 9).
> Considers ways to improve the safety of pedestrians and cyclists, particularly around the more populated areas of the corridor (Chapters 7 and 8).

> Objective 2: Transport and access – provide an efficient road corridor for moving people and goods.

Transport and access are the primary functions of the Bells Line of Road corridor.

Transport efficiency refers to the speed and reliability with which people and goods can move through and circulate within the corridor. Efficiency can be increased by improving the road alignment, increasing road capacity and reducing delays at intersections. To address this Objective, the Plan:

> Reviews current capacity and operation (Chapter 4).
> Reviews expected transport requirements for the corridor, and evaluates these against current capacity (Chapter 4).
Access refers to how efficiently traffic can enter the corridor. Accordingly, the Plan:

- Considers how access for all traffic types may be maintained and supported while minimising impacts on transport efficiency.

Objective 3 – Land use and development

Respond to present and future land uses

An important part of road corridor planning is to ensure that any new or upgraded road is integrated with adjacent land use. Future development of the Bells Line of Road corridor will require consideration of not only existing but also future land use. Accordingly, the Plan:

- Identifies existing and planned land uses along the corridor, including likely future land use patterns within Sydney’s north-west (Chapter 5).
- Assesses whether these land uses are compatible with road development (Chapter 5).

Objective 4 – Environment

Respect the natural and built environment and community values

The Bells Line of Road corridor is a sensitive natural, social and cultural environment. The benefits to be gained from increasing the transport efficiency of the corridor must be balanced against the cost and potential impacts on the community and the environment.

To achieve this Objective, the Plan:

- Maps the social and cultural environment of the corridor, including Aboriginal and non-Aboriginal heritage, and scenic and community values. These characteristics are presented on a series of constraint maps, which provides a valuable tool for corridor planning (Chapter 5).
- Establishes an understanding of how the natural environment could be affected by any future upgrades, acknowledging specific characteristics within the Blue Mountains National Park and Greater Blue Mountains World Heritage Area, as well as areas of natural significance outside designated reserves (Chapters 5 and 7).
3 Community involvement

Community involvement has been integral to the development of the Bells Line of Road Long Term Strategic Corridor Plan.

From 1 November 2010 to 31 January 2011, RMS conducted an extensive community involvement process on the future of Bells Line of Road. The high level of input provided valuable insights into how the community perceives the future of the road, and shows that the road is of interest to the communities it connects as well as the community that lives along it.

This chapter presents key inputs from the community involvement process. The full report of the process is documented in the Community Issues Report, June 2012.

3.1 RMS’ approach to community involvement

RMS’ approach to community involvement has been to ensure that the Plan is developed through extensive consultation with local communities and stakeholders. The following principles have been integral to the consultation process:

> Accessibility of the project team.
> Transparency and public accountability.
> Equitable participation and fair process.
> Continuous improvement.

3.2 Opportunities for community involvement

A range of opportunities have been available to enable as many stakeholders as possible to provide input into the Plan. Community information and opportunities for involvement included:

> Eight separate staffed information sessions and one staffed display where community members had the opportunity to discuss issues with the project team.
> 13 information displays where posters and other information was available. These were at RMS motor registries, local councils and community centres within the project area.
> 12 meetings and forums with local community, special interest and business groups (refer to the Community Issues Report, June 2012, for a list of these groups).
> Briefings to Hawkesbury City Council, Lithgow City Council, Blue Mountains City Council, Forbes Shire Council, Dubbo City Council, Centroc, and the Bells Line Expressway Group.
> A project website with background documents and regularly updated project details.
> An online forum to enable members of the community to post and share their views on the Plan.
> Advertisements in nine local newspapers to raise awareness of the community information sessions.
> 34,000 community updates distributed in the Bells Line of Road corridor area.
> 9,000 postcards to raise awareness of the Plan distributed to a wider area outside the Bells Line of Road corridor.
> A toll free phone line for members of the community to request information and provide feedback.
> A project email address for members of the community to request information and provide feedback.
> Feedback forms, information sessions and constraint maps for the community to provide comment on some specific questions.

3.3 What we asked the community

The communities and stakeholder groups were encouraged to identify:

> Key issues for corridor planning (Section 3.4).
> What needs to happen to the Bells Line of Road corridor in the short, medium and long term (Section 3.5).
> Any constraints to and opportunities for upgrading the Bells Line of Road corridor (Section 3.6).
> Community values to be considered in the Plan (Section 3.7).

3.4 Key issues raised by the community

During the community involvement process, the community raised a range of issues and made many valuable suggestions.

The main issues are summarised below, along with specific issues that occurred most frequently:

> **Safety** – the general condition and safety of the road, including alignment, road surface and width, intersections and visibility.
> **Traffic and access** (which interlinks with safety issues) – the amount, quality and type of traffic, and increased congestion in the eastern section.
> **Environmental impacts** – flora and fauna, endangered ecological communities and potential impacts on tourist and recreational amenity.
> **Regional and local economies** – there is strong support from stakeholders in central and western NSW for improved access through a major upgrade of the route.

Some key comments and concerns are listed below. A full list of issues is available in the Community Issues Report, June 2012.

**Safety**

> Safety on the current road is a major issue of concern to the community, particularly with respect to its crash history, width, surface quality, intersections, alignment and visibility.
> The volume and composition of traffic is considered a major factor influencing the need for short term safety improvements.
> There are also concerns about safety around schools, the lack of a safe cycle route, little or no lane separation, and poor visibility in bad weather.
> Safety is seen as a key area for short term improvement.

**Traffic and access**

> There are concerns about the volume of traffic and the quality of access, as well as increased congestion in the eastern section, particularly in the vicinity of the Richmond Bridge.
> The road in its present form is seen as limiting accessibility between Sydney and central and western NSW.

**Flora and fauna**

> There are concerns about potential impacts on flora and fauna species and ecological communities, especially threatened and endangered species, if the Bells Line of Road were upgraded, or a new road built.

**World heritage**

> There are concerns about the impacts of an upgraded road on the environment of the Blue Mountains and Wollemi national parks, including impacts on scenic values, tourism, cultural heritage and wilderness.

**Noise and amenity**

> There are concerns that a future increase in traffic, especially heavy vehicles and construction traffic, could increase noise, which could affect the amenity of residences and recreational experiences on the Bells Line of Road.
Aboriginal and non-Aboriginal heritage
> There was comment regarding the need to preserve Aboriginal and non-Aboriginal heritage during planning of the corridor.

Local economy
> There are concerns that a bypass or motorway would impact on local businesses. Special mention was made of Mount Tomah Botanic Gardens and local businesses such as the orchards.

Regional economy
> There are concerns about the impacts of not upgrading the road. Some said there is a need to improve the connections between Sydney and central and western NSW, which would bring broad economic benefits to this area.

Property
> There are concerns about the potential length of the planning process and its impact on property owners, and the property market.
> There is concern about the potential of communities being severed or divided should a major upgrade be constructed.

Transport
> There were comments about the suitability of Bells Line of Road as a freight route, its relationship with the Great Western Highway and future rail links as the preferred method to carry freight.

Character and lifestyle
> There are concerns about potentially losing the unique character of the area if a major road upgrade were to occur.

Recreation
> There are concerns about access for recreational users of the corridor (and surrounding recreational areas) and for cyclists.

3.5 How should we improve the road?
The community was asked to suggest improvements to the Bells Line of Road corridor in the short, medium and long term. The community views were as follows.

Short term (0–5 years)
Many community members suggested that safety improvements needed to be carried out immediately. Suggestions included sealing road shoulders, improving road surfaces, removing trees, constructing overtaking lanes, and placing restrictions on heavy vehicles.

Some community members recommended that only short term improvements be completed and that the road be retained as a heritage and tourist attraction, while others suggested that a major upgrade should commence immediately, precluding the need for specific safety improvements.

Medium term (5–20 years)
There were a number of suggestions for medium term improvements. These included increasing the length of sections of the road with two-lanes in each direction; providing a new bridge over the Hawkesbury River at North Richmond; and realigning the steep bends at Bellbird Hill, Mount Tomah and Scenic Hill near Lithgow.

Long term (20+ years)
There were a number of strategic and specific suggestions for the long term future of Bells Line of Road. These included:
> Completing only short term and some medium term improvements and leaving the road as a tourist, local and alternative route.
> Upgrading the rail system to provide better freight and commuter access and reducing the demand on the road network (including Bells Line of Road).
Building a new motorway away from the road or building a new motorway along the current alignment.

New routes suggested by the community
A number of people suggested new routes to connect Sydney and the Central West of NSW. In broad terms, these suggestions included:
> New routes away from the existing Bells Line of Road, including routes through ridgetop and valley terrain in Wollemi and Blue Mountains national parks.
> Routes that represent a combination of the existing Bells Line of Road and a new route alignment.
> Corridor connections to the Sydney motorway network, including routes connecting with the Castlereagh Freeway corridor and the Blacktown Road/Richmond Road corridor.
> Corridor connections to the Great Western Highway, such as via the Newnes Plateau.

While this Plan is not aimed at identifying any specific routes for upgrades, these community ideas have been recorded and may be relevant to future corridor planning stages. Evaluation of any specific routes would involve a detailed examination of associated environmental constraints.

3.6 Opportunities and constraints
The community and stakeholders were asked about opportunities and constraints that should be considered in preparing the Plan. A broad summary of community views are listed below.

What opportunities should be considered?
> The opportunity to implement a two-step approach to the Plan, which would involve completing safety upgrades and then allowing five years for monitoring before considering a major upgrade.
> The opportunity to develop the Bells Line of Road as an expressway from the M7 and M4 motorways to the growing population of the Central West.
> The opportunity to include a potential road corridor in local environmental plans to guide development.
> The potential to locate Sydney’s second airport west of the range, which could include provision of a very fast passenger train service.

What constraints should be avoided or investigated?
Community views regarding constraints to road development included:
> The Bells Line of Road passes through a World Heritage Area. Impacts on the environmentally sensitive area from Bowen Mountain to Mount Tomah could compromise the World Heritage Area, possibly leading to its delisting by the World Heritage Committee.
> An existing system of dams near Grose Vale.
> The potential for a major upgrade of the Bells Line of Road to facilitate urban sprawl over Bellbird Ridge and onto the rural lands between Kurrajong and Berambing.

3.7 Community values
The community and stakeholder groups were asked to respond to the following question: ‘What is it about your area that you value the most?’ Community views included:
> Use of the area for tourism and recreation – the popularity of the drive along Bells Line of Road; in particular Farm Gate, Poets Way and Mount Tomah Gardens; and the importance of the Grose River as a community asset.
> Connections between the communities of the area.
> Regional development – the importance of the Central West region as a significant contributor to food production in NSW.
3.8 Ongoing community involvement

RMS has used the key findings of the community involvement process to inform technical studies and help identify broad strategic opportunities for upgrading the corridor (refer to sections 4, 5 and 6).

While the main consultation phase for the development of the Plan is complete, community members are welcome to contact the project team with questions or additional comments at any time via phone, email or mail (refer to the project website www.rms.nsw.gov.au/roadprojects).
4 Transport analysis

This chapter presents the transport analysis undertaken for the Plan, including the current and future transport needs for the Bells Line of Road corridor, taking into consideration population and traffic forecasts, and the desired ‘level of service’ of the road. The analysis considered traffic that may be attracted to the corridor if a major corridor upgrade was undertaken. It also took into account community feedback on the future of the Bells Line of Road corridor.

4.1 What is the role of the Bells Line of Road?

Measuring how well the Bells Line of Road performs as a thoroughfare first requires an understanding of the roles that the road is required to perform. The road performs three key roles which are consistent with the corridor objectives described in Chapter 2:

Local access road – the road provides for local access, often for relatively low traffic volumes and including in some locations access for pedestrians and cyclists. To fulfil this role, it is not necessary for the road to enable high traffic speeds. Instead, the relevant measure of service quality is the level of delay, as indicated by the formation of vehicle ‘platoons’, which occur when a line of vehicles is stuck behind a slower vehicle.

Through route – the road provides an access route enabling motorists to travel between town centres, including Sydney, Lithgow and centres in central and western New South Wales. In this role, the road serves long-distance and regional commercial, residential and recreational travellers. To fulfil this role, it would ideally allow consistent high speeds and provide sufficient opportunities for overtaking.

Scenic route – the road also serves scenic and recreational areas in which the vista and environment may be experienced and enjoyed, while in transit or by stopping at key locations. In this role, safety is important, but high speeds may neither be expected nor desired.

4.2 Measuring road performance

RMS measures and monitors the road network through network performance measures and manages road network impacts through targets. These measures and targets are described in RMS’s Network Performance Measures and Network Planning Targets document of July 2010. This document includes a target that roads with characteristics similar to Bells Line of Road should operate at Level of Service C.

The ‘level of service’ (LOS) of a road is a quality measure of aspects such as speed and travel time, freedom to manoeuvre, lack of traffic interruptions, and comfort and convenience. Safety is not included in the measures that establish levels of service, as it is considered as a separate key area for assessment.

LOS is measured in terms of per cent time-spent-following. This is the average percentage of travel time that vehicles must travel in platoons behind slower vehicles due to an inability to pass.

Six levels of service are normally used in transport analysis, and are designated by letters at each level from A to F, with LOS ‘A’ representing the best operating conditions and LOS ‘F’ the worst. Each LOS represents a range of operating conditions and the driver’s perception of those conditions.

LOS definitions are shown in Table 4.1.
4 Transport analysis

Table 4.1 Level of service definitions for two-lane highways

<table>
<thead>
<tr>
<th>LOS</th>
<th>% time following</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Less than 40</td>
<td>Free flow, low volume, high speed</td>
</tr>
<tr>
<td>B</td>
<td>40–55</td>
<td>Stable flow, operating speed slightly restricted</td>
</tr>
<tr>
<td>C</td>
<td>55–70</td>
<td>Stable flow, speed and manoeuvrability restricted</td>
</tr>
<tr>
<td>D</td>
<td>70–85</td>
<td>Approaching unstable flow, freedom to manoeuvre restricted</td>
</tr>
<tr>
<td>E</td>
<td>Greater than 85</td>
<td>Unstable maximum flow at capacity, no freedom to manoeuvre</td>
</tr>
<tr>
<td>F</td>
<td>Volume greater than capacity</td>
<td>Forced flow, frequent stopping and queuing</td>
</tr>
</tbody>
</table>

4.3 RMS road management hierarchy

RMS has produced a series of ‘Practice Notes’ designed for use in the development of network and corridor strategies (Network and Corridor Planning Practice Notes, NSW RTA, November 2008).

Practice Note 3 describes RMS’ management hierarchy for the State road network. The hierarchy divides the network into six classes of urban roads and six classes of rural roads. The classification system serves as a basis for identifying appropriate performance levels for different road categories to guide investment decisions. Table 4.2 is drawn from Practice Note 3.

The Bells Line of Road is classed as a ‘3U’ road (U stands for urban). However, the Network Planning Targets described in Section 5.2 recommend that rural roads within the urban boundary be assessed under rural criteria. Bells Line of Road (west of Kurrajong) is rural in character and function and is therefore assessed in this Plan as a rural road (3R).

Table 4.2 Road network management hierarchy
(from RMS Network and Corridor Planning Practice Notes, 2008)

<table>
<thead>
<tr>
<th>Road class</th>
<th>Average annual daily traffic</th>
<th>Heavy vehicles (average/day)</th>
<th>Typical road standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>1U</td>
<td>1000</td>
<td>50</td>
<td>Undivided two-lanes with limited kerbside parking restrictions</td>
</tr>
<tr>
<td>1R</td>
<td>500</td>
<td>50</td>
<td>Undivided two-lanes</td>
</tr>
<tr>
<td>2U</td>
<td>5000</td>
<td>400</td>
<td>Two-lane two-way undivided</td>
</tr>
<tr>
<td>2R</td>
<td>1500</td>
<td>250</td>
<td>Two-lane two-way undivided</td>
</tr>
<tr>
<td>3U</td>
<td>13,000</td>
<td>1000</td>
<td>Two-lane two-way undivided</td>
</tr>
<tr>
<td>3R</td>
<td>4500</td>
<td>500</td>
<td>Two-lane two-way undivided</td>
</tr>
<tr>
<td>4U</td>
<td>29,000</td>
<td>1600</td>
<td>Four-lane two-way undivided</td>
</tr>
<tr>
<td>4R</td>
<td>10,000</td>
<td>1000</td>
<td>Two-lane two-way undivided with overtaking lanes</td>
</tr>
<tr>
<td>5U</td>
<td>37,000</td>
<td>2500</td>
<td>Four-lane two-way undivided</td>
</tr>
<tr>
<td>5R</td>
<td>12,000</td>
<td>1200</td>
<td>Divided and undivided carriageways, frequent overtaking opportunities</td>
</tr>
<tr>
<td>6U</td>
<td>50,000+</td>
<td>3500</td>
<td>Divided carriageway four or more lanes</td>
</tr>
<tr>
<td>6R</td>
<td>12,000+</td>
<td>2500</td>
<td>Divided carriageway four or more lanes</td>
</tr>
</tbody>
</table>
4.4 How the current transport network performs

4.4.1 Traffic volumes on the Bells Line of Road

Traffic counts were undertaken along the Bells Line of Road corridor in April and May 2011, as part of the development of this Plan. The results of these counts are shown in Table 4.3 and Figure 4.1 (Figure 4.1 includes additional counts on the Great Western Highway) and show the higher traffic volumes that occur at the eastern end of Bells Line of Road when compared to the central sections.

Analysis of historical traffic counts was also undertaken to gain a broader understanding of traffic volumes. The results of this suggest that traffic volumes can vary considerably across different days of the week and at different times of the year. Traffic data shows that:

> The Bells Line of Road serves significant weekend activities along some sections. In the central section from Bell to Bilpin, volumes on Sunday were highest. Friday and Saturday volumes were higher than for other days of the week.
> At Kurrajong, traffic was heavier on Friday and Saturday.
> In Richmond, traffic was heavier on weekdays.
> At Kurrajong there is higher travel activity on the Bells Line of Road in February and September, and lower activity in March–April and November–December.
> Near Bell there is little seasonal variation in traffic volumes.

<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
<th>Avg daily volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bells Line of Road, North Richmond</td>
<td>16,210</td>
</tr>
<tr>
<td>2</td>
<td>Bells Line of Road near Comleroy Road, Kurrajong</td>
<td>12,150</td>
</tr>
<tr>
<td>3</td>
<td>Bells Line of Road near Coach House Road, Kurrajong Heights</td>
<td>4,800</td>
</tr>
<tr>
<td>4</td>
<td>Bells Line of Road, Bilpin</td>
<td>4,000</td>
</tr>
<tr>
<td>5</td>
<td>Bells Line of Road, eastern side Mount Tomah</td>
<td>3,300</td>
</tr>
<tr>
<td>6</td>
<td>Bells Line of Road, east of Bell</td>
<td>3,440</td>
</tr>
<tr>
<td>8</td>
<td>Chifley Road, west of Bell</td>
<td>3,270</td>
</tr>
<tr>
<td>10</td>
<td>Chifley Road, east of Lithgow near Hartley Valley Road</td>
<td>3,690</td>
</tr>
</tbody>
</table>

Note: The site numbering in Table 4.3 is not sequential as the numbering system refers to the overall transport analysis and not all analysis points involved repeated traffic counts.

4.4.2 Travel behaviour

Travel behaviour in the Bells Line of Road corridor and north-western Sydney can be summarised as follows:

> Peak travel times – there are distinct morning (8–9am) and afternoon (3–6pm) peaks on weekdays. The afternoon peak is higher at school finishing time and extends to business hour finishing time. The weekend peak is of lower intensity than the weekday morning and afternoon peaks, but is longer, spanning several hours across the middle of the day.
> Reasons for travel – the dominant trip purposes in weekday morning peak periods are education/childcare journeys and travel to work. The dominant weekday afternoon peak trip purpose is to return home, and the dominant weekend trip purpose is for social/recreation purposes.
> Private vehicle use – the car is the dominant mode of travel, particularly on weekends.
4.4.3 Travel between Bells Line of Road and the Sydney motorway network

Surveys of travel patterns in the eastern section of the Bells Line of Road corridor were undertaken in May 2011. These surveys sought to quantify the volumes of traffic travelling between the Bells Line of Road to/from the Sydney motorway network (via the M7). These outcomes can inform further detailed analysis of the rationale for provision of connections between the Bells Line of Road and the Sydney motorway network.

The surveys were undertaken over a 12 hour period on a typical weekday. During the survey period (6:30am–6:30pm), some 3,900 vehicles were recorded travelling eastbound on the Bells Line of Road at Kurrajong. Of these, some 380 vehicles (around 10 per cent) travelled onwards to Richmond Road near Garfield Road heading in the direction of the M7. A total of 450 vehicles (around 11 per cent) travelled by a different route to Windsor Road as far as Groves Avenue in the direction of the M7. In the reverse direction, some 380 vehicles were recorded travelling from Richmond Road and some 390 vehicles from Windsor Road through to the Bells Line of Road at Kurrajong. Based on expansion factors obtained from the traffic count data, this would suggest that up to 2,000 vehicles (both directions combined) travel between the Bells Line of Road at Kurrajong and the M7 on a typical weekday.

These counts also suggest a relatively even division of use between the two main existing corridors that connect Bells Line of Road with the Sydney motorway network.

4.4.4 Historical traffic growth

Historical changes in traffic volume for selected locations on the Bells Line of Road and Great Western Highway were evaluated as part of this Plan on the basis of previous traffic count data from RMS. This indicated that growth rates along the Bells Line of Road corridor were generally low, except for Marrangaroo on the Great Western Highway.

Traffic growth was assessed at locations on the Bells Line of Road and Great Western Highway. Figure 4.2 presents these growth rates. It shows that:

> Long term traffic growth on the Bells Line of Road has generally been below 1.0 per cent per annum.

> Growth rates have picked up in some locations since 2005, but have generally remained below 1.5 per cent per annum, with the exception of Kurrajong. Traffic volumes at Kurrajong decreased after 2002 and, while traffic has grown at a higher rate since 2005, volumes are still below 2002 levels.

> Growth rates on the Great Western Highway to the west of the Darling Causeway have been stronger.

4.4.5 Identifying a traffic design criterion

It is not cost-effective or efficient to plan and design transport facilities to cater for the single highest peak daily (or hourly) transport demand that may be expected in any given future year. Instead, transport facilities need to be designed to cater for projected demands throughout the year. This approach recognises that the level of service will decline for a few hours or days of extremely high demand, but will be better than the design standard on an average day.

RMS’ Network Performance Targets document aims for performance at level of service C in the 100th highest traffic hour of the year. The 100th highest traffic hour was estimated as being the peak hour of the 100th highest traffic day of the year (as a full year of hourly data was not available for any of the sites).
4.4.6 Existing level of service of the Bells Line of Road

The existing level of service (LOS) was calculated at various points along the Bells Line of Road and Great Western Highway. The Great Western Highway was included in the analysis to provide a picture of the overall performance of the cross-mountain road network.

The LOS for the Bells Line of Road and Great Western Highway was calculated at the locations shown in Table 4.4.

**Table 4.4 Sites used for LOS analysis**

<table>
<thead>
<tr>
<th>Site</th>
<th>Road</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bells Line of Road</td>
<td>Kurrajong – east of Comleroy Road</td>
</tr>
<tr>
<td>2</td>
<td>Bells Line of Road</td>
<td>Bilpin – west of Post Office</td>
</tr>
<tr>
<td>3</td>
<td>Bells Line of Road</td>
<td>East of Darling Causeway</td>
</tr>
<tr>
<td>4</td>
<td>Bells Line of Road</td>
<td>East of Darling Causeway</td>
</tr>
<tr>
<td>5</td>
<td>Chifley Road</td>
<td>West of Darling Causeway</td>
</tr>
<tr>
<td>6</td>
<td>Chifley Road</td>
<td>West of Bell</td>
</tr>
<tr>
<td>7</td>
<td>Chifley Road</td>
<td>Lithgow – east of Hartley Valley Road</td>
</tr>
<tr>
<td>8</td>
<td>Darling Causeway</td>
<td>South of Bells Line of Road</td>
</tr>
<tr>
<td>9</td>
<td>Great Western Highway</td>
<td>Faulconbridge – west of Bellevue Road</td>
</tr>
<tr>
<td>10</td>
<td>Great Western Highway</td>
<td>West of Soldiers Pinch</td>
</tr>
<tr>
<td>11</td>
<td>Great Western Highway</td>
<td>West of McKanes Falls Road</td>
</tr>
<tr>
<td>12</td>
<td>Great Western Highway</td>
<td>Marrangaroo, west of Castlereagh Hwy</td>
</tr>
<tr>
<td>13</td>
<td>Bells Line of Road</td>
<td>North Richmond, west of Grose Vale Rd</td>
</tr>
<tr>
<td>14</td>
<td>Bells Line of Road</td>
<td>West of Coach House Road</td>
</tr>
<tr>
<td>15</td>
<td>Bells Line of Road</td>
<td>East of Mount Tomah Botanic Garden</td>
</tr>
</tbody>
</table>

The results of the LOS analysis for 2011 traffic volumes are shown in Figure 4.3.

The existing LOS analysis shows that:

> The central and western sections of the Bells Line of Road are generally operating at good LOS, with LOS ‘A’ through ‘C’ being typical.

> The eastern section of the Bells Line of Road operates at poorer levels of service. On the approaches to North Richmond, the environment is increasingly urban and the constraints for traffic occur at intersections rather than mid-block.
Figure 4.3
Existing level of service
4.4.7 Freight and trucks

**Truck volumes**

The Bells Line of Road plays an important role as a route for transporting freight, operating as a secondary route to the Great Western Highway.

**Table 4.5** shows the proportion of heavy vehicles on the Bells Line of Road corridor during an average weekday as surveyed in March and April 2011.

<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
<th>Heavy vehicles (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bells Line of Road</td>
<td>North Richmond</td>
<td>6</td>
</tr>
<tr>
<td>Bells Line of Road</td>
<td>Comleroy Road, Kurrajong</td>
<td>12</td>
</tr>
<tr>
<td>Bells Line of Road</td>
<td>Coach House Road, Kurrajong Heights</td>
<td>8</td>
</tr>
<tr>
<td>Bells Line of Road</td>
<td>Bilpin</td>
<td>9</td>
</tr>
<tr>
<td>Bells Line of Road</td>
<td>Eastern side of Mt Tomah</td>
<td>9</td>
</tr>
<tr>
<td>Bells Line of Road</td>
<td>Bell</td>
<td>8</td>
</tr>
<tr>
<td>Chifley Road</td>
<td>West of Bell</td>
<td>13</td>
</tr>
<tr>
<td>Chifley Road</td>
<td>East of Lithgow near Hartley Valley Road</td>
<td>10</td>
</tr>
<tr>
<td>Great Western Highway</td>
<td>Near McKanes Falls Road</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 4.5 shows there is a high proportion of heavy vehicles in the western section of the Bells Line of Road corridor, with trucks making up to 10–13 per cent of traffic on an average weekday.

**Truck travel restrictions and access to ports**

Travel restrictions are placed by RMS on trucks using the Bells Line of Road and Great Western Highway. For example:

> The Bells Line of Road and Great Western Highway are not approved for travel by B-doubles longer than 19 metres and with a total mass greater than 50 tonnes.
> The Bells Line of Road is approved for vehicles up to 4.6 metres high, whereas the Great Western Highway is not. Vehicles of this height include car carriers, trucks with wool or hay bales, high containers and livestock crates.
> Overmass vehicles are permitted on the Great Western Highway but not on the Bells Line of Road.
> As a result, there are no direct routes for larger B-doubles (longer than 19 metres) from the central and west regions of NSW to Sydney via the Blue Mountains.

**Rail freight**

Rail freight from the central and western regions of NSW serves both domestic and export markets. The majority of freight comprises bulk coal and containerised minerals, which are moved to Sydney and then to Port Botany and Port Kembla by rail over the Blue Mountains, and to Newcastle via the Ulan line. There are major constraints on increased rail freight from the Central West. These include:
The significant growth in passenger trains within the Sydney metropolitan network, which reduces the availability of freight paths as a result of freight restrictions during commuter peaks.

Short passing and crossing loops as well as insufficient passing and crossing loops.

The constraints on increased rail freight, if they are not alleviated, will likely reinforce the importance of the Bells Line of Road as a secondary route for freight movements across the Blue Mountains.

4.4.8 Public transport

Rail and bus services are available for passengers travelling between Sydney and the Central West.

**Rail services**

Rail services between Sydney and western NSW travel via the Main Western railway line. Services are run by CityRail (Sydney Central Station–Lithgow) and CountryLink (Sydney–Dubbo via Lithgow). Services from the east to Lithgow diminish further westwards as population concentrations reduce. There is also a same-day return from the Central West to Sydney by bus, with an interchange at Lithgow for CityRail services.

CityRail statistics for rail passenger flows in 2008 show that an average of 6000 passengers travelled on the Blue Mountains Line via Emu Plains to Sydney on weekdays, and 2400 on weekend days.

**Public bus services**

Westbus operates two bus services on the eastern section of the Bells Line of Road, on routes 680 and 682. These routes provide frequent services along the Bells Line of Road between Richmond railway station and Kurrajong, and between Richmond station and Berambling.

4.5 Future network performance

4.5.1 Population projections

The majority of users of the Bells Line of Road corridor live in the Western Sydney Regional Organisation of Councils (WSROC) and Central Region Organisation of Councils (Centroc) regions. Population projections for these regions have generally been revised downwards in recent years, particularly for the Centroc region. Figure 4.4 shows population projections for the Centroc region produced by:

The NSW Department of Planning (2010). These projections have negative growth rates for the Central West region after 2026.

Sinclair Knight Merz (SKM). SKM identified these traffic projections for the Bells Line of Road in its 2009 study.

The Western Research Institute (WRI, 2008). WRI developed forecasts for three scenarios, based on different assumptions for migration of employees to new jobs within the region.

Figure 4.4 also shows the most recent (2010 release) Department of Planning growth rate projections for WSROC, including the Hills Shire. These figures reflect population growth in line with land releases in the North West Growth Centre.

Table 4.6 shows the population growth rates implied by these projections.
Figure 4.4 Population projections for Centroc and WSROC regions
### 4.5.2 Road network improvements

RMS has been progressively upgrading the Great Western Highway in the Blue Mountains.

The upgrade projects involve widening the highway to four-lanes between Emu Plains and Katoomba and to mostly three lanes between Katoomba and Mount Victoria.

The Great Western Highway is a key route for transporting freight between Sydney and the Central West region, with more than half the road freight between Sydney and the Central West using the highway. It is also a tourist route to destinations such as the Blue Mountains, historic Hartley, Jenolan Caves, Mudgee and Bathurst. Importantly, it also functions as a local access road, connecting the many towns and villages along its length.

The ongoing upgrades of the Great Western Highway reinforce the role of the highway as the primary road crossing of the Blue Mountains. Construction of four-lanes to Katoomba is anticipated by 2014. By providing faster and more reliable travel times, it will maintain its current share of trips across the Blue Mountains, or even attract a greater share from the Bells Line of Road. This is discussed further below.

### Table 4.6 Population growth rates implied in forecasts for Centroc and WSROC

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NSW DoP (2010)</td>
<td>0.2%</td>
<td>0.2%</td>
<td>0.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>NSW DoP (2005)</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.2%</td>
</tr>
<tr>
<td>WRI–Scenario A</td>
<td>1.8%</td>
<td>1.2%</td>
<td>0.3%</td>
<td>0.1%</td>
</tr>
<tr>
<td>WRI–Scenario B</td>
<td>1.1%</td>
<td>0.8%</td>
<td>0.2%</td>
<td>0.1%</td>
</tr>
<tr>
<td>WRI–Scenario C</td>
<td>0.5%</td>
<td>0.4%</td>
<td>0.2%</td>
<td>0.1%</td>
</tr>
<tr>
<td>WSROC + Hills NSW DoP (2010)</td>
<td>2.5%</td>
<td>2.0%</td>
<td>1.8%</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

### 4.5.3 Traffic forecasts

#### Basic growth rates

Traffic on Bells Line of Road has generally grown by 1.0–1.5 per cent per annum over the past five years, with the exception of Kurrajong, which has more recently been growing at up to 3 per cent per annum but has still not reached traffic volumes recorded in 2002.

This Plan employs a basic growth rate of 1.0 per cent per annum for traffic on the length of Chifley Road and the Bells Line of Road west of Kurrajong, and 1.5 per cent per annum on the Bells Line of Road to the east of Kurrajong, which takes growth trends into account.

A ‘higher growth’ scenario was also developed to assess the potential impacts of additional traffic growth above the trend growth rates. This scenario employed growth rates of 2.0 per cent per annum for Chifley Road and the Bells Line of Road west of Kurrajong, and 3.0 per cent per annum for the Bells Line of Road east of Kurrajong.

Estimates of the average day’s traffic volume for 2030 and 2050 were produced during the preparation of this Plan, for different locations along the corridor, including locations on the Great Western Highway (for which a growth rate of 0.5–1.5 per cent per annum was used in the basic case and 1.0–3.0 per cent per annum for the higher growth case). The resulting forecast traffic volumes for the basic case are shown in Figure 4.5. Forecast volumes for the higher growth case are shown in Figure 4.6.

Figures 4.5 and 4.6 show that of the locations on Bells Line of Road – Chifley Road, only two locations (site 1 east of Comleroy Road and site 2 within the East Richmond town area) would carry over 10,000 vehicles per day by 2050.
Under the RMS network management hierarchy system (see Table 4.2), the Bells Line of Road (in its entirety) would not warrant upgrading to a four-lane divided road in the foreseeable future if traffic volumes alone are considered. This is consistent with findings of previous studies such as the Bells Line of Road Corridor Study (SKM, 2004) and the Central West Transport Needs Study (SKM, 2009).

**Forecast level of service**

Level of service (LOS) has been calculated in relation to the projected traffic volumes and based on standard rural road assessment procedures which use percent time following as a measure. The forecast LOS also suggests that upgrading the entire Bells Line of Road to a four-lane divided road within the foreseeable future is not warranted on traffic performance grounds alone (Figure 4.6). The assessment forecast the LOS in peak periods for locations on the Bells Line of Road in future years. It was found that:

- By 2030, levels of service would be LOS C or better, with the exception of locations east of Kurrajong Heights (which would be either LOS D or E).
- By 2050, levels of service would be generally LOS C for locations west of Bilpin. This site and sites to the east would be either LOS D or E in peak periods. It is likely that the lower level of service in 2050 at Bilpin is associated with localised traffic movements in and around the township.

### 4.5.4 The effect of potential corridor improvements

**Generated and induced demand**

Road improvements save travel time and vehicle operating costs for road users and make roads safer. However, these improvements can also generate or induce an increase in traffic volumes on the improved road.

Generated traffic is defined as changes in existing trips and can be caused by travellers:

- Changing their route to the improved road.
- Extending their trip (for example, to shop further away).
- Switching from bus or train to car.
- Time shifting (for example, departing later in the peak period rather than before it).
Induced travel is defined as new trips that have been created by road improvements. Induced travel can be caused by:

> New trips that had not been made before.
> Additional travel resulting from changes in land use and development.
> Reductions in car sharing, and reductions in vehicle occupancy, which lead to increased numbers of car trips.

Generated and induced demand impacts tend to occur over different time horizons:

> Generated traffic occurs in the short run soon after road improvements are made because people are able to easily change their route and time decisions.
> Induced travel tends to take longer as many people are not able to quickly make large lifestyle changes – eg the number of cars they own, where they live, etc. Land use changes that take advantage of transport infrastructure improvements also take time to develop.

**Generated and induced demand from upgrading the Bells Line of Road**

There has been considerable discussion prior to the preparation of this Plan as well as during consultation for the Plan regarding whether traffic volume increases above trend growth would occur if the corridor was upgraded to a higher standard (such as a four-lane dual carriageway highway) for its entire length. Specific sources of additional traffic volume that have been identified include:

> Traffic (both light and heavy vehicles) choosing to travel on Bells Line of Road rather than the Great Western Highway because it offers a more efficient route.
> Trucks from some parts of the Central West of NSW that currently use the Hume Highway instead choosing to access Sydney via Bells Line of Road.
> An upgraded Bells Line of Road corridor acting as a catalyst for increased economic development and population growth west of the Blue Mountains, which would in turn generate higher levels of cross-mountain traffic.

This potential generated and induced demand is evaluated below on the basis of previous research that relates travel time savings to traffic volume increases.
Figure 4.7
Forecast level of service – basic growth scenario
The Bells Line of Road serves a range of different trip types with varying trip lengths. Work by Sinclair Knight Merz (2004) indicates that development of the Bells Line of Road into a high-standard four-lane divided road would result in travel time savings for cross-mountain trips of around 20 per cent.

A variety of research into the effect of time savings on generated and induced demand has been reviewed as part of this Plan. This review has shown that if the highest of the scenarios identified by this research is used, a 20 per cent time saving can be regarded as resulting in up to a 27 per cent increase in traffic on rural roads.

To take this into account, traffic forecasts described in Section 4.4.3 were recalculated, assuming that 80 per cent of cross-mountain traffic using the Great Western Highway (around 2,400 vehicles) would divert to an upgraded Bells Line of Road, and then factoring in this induced demand figure. This diversion percentage is considered to be the maximum number that would divert to Bells Line of Road under any foreseeable circumstance.

Figures 4.8 and 4.9 show the traffic projections with the induced demand estimate added to the basic growth case and high growth case volumes at the Bells Line of Road and Chifley Road sites respectively.

Figures 4.8 and 4.9 show that, even with these highly optimistic estimates of induced demand that may result from a major upgrade of the Bells Line of Road, traffic volumes on the Bells Line of Road and Chifley Road corridor west of Kurrajong are likely to be at or below around 12,000 vehicles per day in 2050.

Forecast volumes to the east of Kurrajong Heights are higher, and indicate that an upgrade would be warranted under the current RMS management guidelines.

This alone is unlikely to form a basis for the justification of a major upgrade to the Bells Line of Road to four-lane standard through these sections, and any investigation of an upgrade of these sections will need also to consider engineering, construction cost, economic, social and environmental factors.

### 4.6 Overview of the transport analysis

The transport analysis of the Bells Line of Road found that:

> Long term traffic growth rates on the Bells Line of Road have generally been below 1.0 per cent per annum. Growth rates have picked up since 2005, but have generally remained below 1.5 per cent per annum. Traffic growth rates on the Great Western Highway to the west of the Darling Causeway have been stronger than on the Bells Line of Road.

> The central and western sections of the Bells Line of Road are generally operating at good levels of service.

> The portion of Bells Line of Road in the vicinity of North Richmond is currently performing poorly, with high levels of traffic congestion in peak periods.

> Existing traffic between Bells Line of Road and the Sydney motorway network is evenly divided between the Windsor Road/Old Windsor Road corridor, and the Blacktown Road/Richmond Road corridor.

> Forecast traffic numbers based on an optimistic growth trend do not reach the levels that would trigger a need to upgrade the full length of Bells Line of Road to four-lanes in any foreseeable planning horizon.

> Forecast traffic numbers based on an optimistic growth trend plus potential induced demand also do not reach the levels that would trigger a need to upgrade the full length of Bells Line of Road to four-lanes in any foreseeable planning horizon.
Figure 4.8
Forecast average daily traffic volumes – basic growth case with induced traffic from road upgrade

Figure 4.9
Forecast average daily traffic volumes – high growth case with induced traffic from road upgrade
> Forecast traffic numbers suggest that there may be a need to upgrade a portion of Bells Line of Road (east of approximately Kurrajong Heights) to four-lanes in the long term.
5 Constraint analysis

This chapter presents the constraint and opportunity analysis for the 11 social, environmental and technical factors that were assessed as part of the Plan. It includes the maps for each analysis and a combined constraint map.

5.1 Introduction

As part of the planning for the Bells Line of Road corridor a constraint and opportunity analysis was prepared to assess existing conditions within the Bells Line of Road corridor that may influence the location and nature of future road development. It is a high level of analysis, undertaken at a level of detail appropriate for strategic corridor planning.

The constraint analysis involved mapping social, environmental and technical information about potential opportunities and constraints within the corridor and is an important tool for preparing the Plan and for detailed corridor planning. The extent of mapping covers about five kilometres either side of the Bells Line of Road and extends to include the Sydney motorway network.

The constraint analysis was based on key findings from previous studies, as well as more recent information gathered during the preparation of the Plan, including the outcomes of the community involvement process, where the community was specifically asked to identify constraints that may affect future road development.

Topic areas

The analysis looked at the following 11 social, environmental and technical factors:

> Land use
> Geotechnical
> Ecology
> Landscape character
> Visual character
> Aboriginal heritage
> Non-Aboriginal heritage
> Water quality
> Flooding
> Noise
> Air quality

How the constraints were mapped and classified

To identify the importance of each potential constraint, classifications of high, medium and low were assigned to each area. These classifications reflect the significant local issues within the corridor. Generally speaking, for an individual area or environmental factor:

> A high constraint suggests that road development would be undesirable in terms of that environmental factor and would need a strong justification, careful design and environmental management measures to be implemented.
> A moderate constraint suggests that the road development would have potential impacts that require consideration in terms of design and appropriate environmental management.
> A low constraint suggests that the road development would have a lower impact and there is greater certainty around the possible design solutions and measures to minimise impacts.

The constraint analysis for the 11 factors is presented below.
Limitations and assumptions

The constraint analysis uses the following limitations and assumptions:

> The maps show existing conditions within the corridor at a broad scale.
> The analysis is based on available data, with limited field investigation.
> The analysis covers a large corridor and a vast amount of spatial data. The broad level of the spatial data limits the details available at a local level.

Specific limitations within topic areas are discussed in the relevant sections below. It should be noted that any specific programs or projects arising from the plan would be subject to environmental impact assessment and planning approval processes, where detailed investigations would be carried out, as appropriate.

5.2 Land use

The Bells Line of Road corridor contains many important and varied land uses. These existing land uses and identified growth areas will be a key influence on future road development within the corridor.

5.2.1 Mapping methodology

The land use constraint analysis considered the impact that future road development may have on current and future land uses. Key land uses within the corridor were assigned a constraint classification, as summarised below.

High constraint
> Residential
> Open space – environmental protection (including national parks and World Heritage areas).

Moderate constraint
> Future proposed urban development (including the North West Growth Centre).
> Commercial land.
> Small rural lots (less than 10 hectares within a rural land use class).
> Active fruit growing.
> Special use and community facilities.
> Floodplain agriculture.

Low constraint
> Industrial land
> Infrastructure (including existing road reserves, easements and the Castlereagh Corridor).
> State forest
> Large rural lots (greater than 10 hectares).

5.2.2 Community input

Community comments and feedback relating to land use highlighted:

> The importance of the village settlement pattern adjacent to the Bells Line of Road.
> The amenity and value of villages, including Kurrajong Hills and the residential areas around Bowen Mountain and Grose Vale.
> The potential impacts on traffic congestion due to land use changes.
> The potential impacts of a bypass or motorway on local businesses (eg The Apple Bar, Tutti-Frutti, and The Turpentine Tree), and tourist attractions (eg Mount Tomah Botanic Gardens, orchards and slot canyons).
> Concerns about the length of the planning process. This could create uncertainty for prospective buyers of properties, who could be hesitant to purchase properties due to concern about the potential for future road widening.

5.2.3 Mapping results

Land use constraints are shown in Figure 5.1.

**High constraint areas**

> The largest concentration of high constraint is associated with the central section, with smaller, more isolated areas of high constraint in the eastern and western areas.
> The largest continuous area of high constraint is associated with the Blue Mountains and Wollemi national parks. More dispersed areas of high constraint in the eastern and western sections reflect residential centres including Richmond, North Richmond, Windsor, Quakers Hills and Lithgow. High constraint in these areas can also be attributed to open space (nature reserves, including Shanes Park and recreational facilities), mining (quarries in the east and mainly coal operations in the west) and Department of Defence land.

**Moderate constraint areas**

> In the central areas and to the west of Richmond, the moderate constraint reflects the village settlement pattern of smaller rural lots (particularly around Mount Tomah, Mount Wilson and Bilpin) and the presence of fruit growing.
In the eastern section, the moderate constraint highlights the North West Growth Centre and special use/community facilities such as the University of Western Sydney campus and TAFE NSW Western Sydney campus. Moderate constraint also reflects the occurrence of specialised agriculture associated with the Hawkesbury River flood plain, fruit growing and small lot settlements.

In the western section, moderate constraint is associated with the Newnes State Forest and the small lot village settlements of Clarence and Little Hartley.

**Low constraint areas**

- Low constraint areas along the corridor reflect the presence of large rural lots.
- Low constraint in the eastern section reflects areas of infrastructure, including the Castlereagh Corridor.

### 5.2.4 Future investigations

The land use analysis represents a snapshot of current and known future land uses. Any future planning or implementation of upgrade(s) will need to consider any planned changes to land use likely to occur, including any additional mining operations. As such, the land use constraint map will need to be updated, and will need to include detailed site-specific land use investigations.

Additionally, native title (including land subject to native title claims) and Aboriginal-owned land will need to be considered for any future planning.
5.3 Geotechnical

The Bells Line of Road corridor is geologically and geotechnically diverse, with mountainous areas associated with the Blue Mountains National Park contrasting with the Cumberland floodplain and Hartley Valley. The geotechnical constraint analysis considered geological and geotechnical conditions that would influence road constructability, and geotechnical hazard during the operational phase of road development.

5.3.1 Mapping methodology

The geotechnical constraint analysis considered the following aspects:

> Slope – slope is an indicator of geotechnical hazard. Higher areas of slope generally contribute to a higher level of hazard.
> Slope curvature – slope curvature is an indicator of the change in slope. Cliff areas and drainage lines have a high curvature value as they represent difficult areas for road construction.
> Geology – different geological types have characteristics that influence both constructability and geotechnical hazard.
> Faults and neotectonics – fault lines present particular geotechnical hazards.
> Rivers – river crossings present particular constructability issues due to the geotechnical characteristics of riverbeds and banks.
> Mines – mines often create areas of instability and subsidence.
> Geomorphology – different geomorphological features exhibit different characteristics in terms of stability and, therefore, geotechnical hazard.
> Acid sulphate soils – these exhibit particular characteristics (apart from their environmental risks) that influence constructability, primarily in relation to their potential to corrode construction materials.

Each geotechnical aspect was classified as either a high, moderate, low or null constraint based on its influence on any future road upgrade. The final geotechnical constraints map is a composite of all the input constraint maps. Constraint classifications for each of the above aspects are summarised in Table 5.1.
Table 5.1  Geotechnical constraint classifications

<table>
<thead>
<tr>
<th>Low constraint</th>
<th>Moderate constraint</th>
<th>High constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope</td>
<td>Slopes less than 5</td>
<td>Slopes greater than 15</td>
</tr>
<tr>
<td>Slope curvature</td>
<td>–</td>
<td>Cliffs</td>
</tr>
<tr>
<td></td>
<td>–</td>
<td>Drainage lines</td>
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<td>Geology</td>
<td>Sandstone</td>
<td>Volcanics</td>
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<td></td>
<td></td>
<td>Quarternary alluvium and colluvium</td>
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<td></td>
<td></td>
<td>Shale</td>
</tr>
<tr>
<td>Faults and neotectonics</td>
<td>Greater than 25 m from the Kurrajong Fault</td>
<td>Less than 25 m from the Kurrajong Fault</td>
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<tr>
<td></td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Rivers</td>
<td>Greater than 200 m from rivers</td>
<td>Less than 200 m from rivers</td>
</tr>
<tr>
<td></td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Mines</td>
<td>–</td>
<td>Less than 1 km from coal mines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Less than 500 m open (gravel) mines</td>
</tr>
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<td></td>
<td></td>
<td>Known boundaries of mines</td>
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<tr>
<td>Geomorphology</td>
<td>Tunnel locations</td>
<td>Drainage</td>
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<td>Areas of potential palaeochannels</td>
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<td></td>
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<td>Historic landslide features</td>
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<td></td>
<td>Cliffs</td>
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<td></td>
<td></td>
<td>Rocky outcrops</td>
</tr>
<tr>
<td>Acid sulphate soils (ASS)</td>
<td>Areas mapped with a probability of encountering ASS between 6–70%</td>
<td>Areas mapped with a probability of greater than 70% of encountering ASS</td>
</tr>
</tbody>
</table>

5.3.2 Community input

There were limited community concerns raised regarding geotechnical constraints. Specific concerns were raised about the preservation of slot canyons, which are considered to be irreplaceable heritage and recreational resources. The most popular canyons for visitors are very close to the road, and are less than a metre wide. Recreational canyons will need to be considered in future corridor development activities.
5.3.3 Mapping results

Geotechnical constraints are shown in Figure 5.2.

**High constraint areas**
- High geotechnical constraint is associated with the more mountainous areas of the central and western sections, reflecting high slope as well as less stable geological units.

**Moderate constraint areas**
- Moderate constraint is associated with the flatter areas of the Cumberland Plain (eastern section) and Hartley Valley (western section), as well as isolated areas along the ridgeline (central section).

**Low constraint areas**
- Low constraint is generally restricted to small areas in the west, around the Newnes Plateau and small, isolated areas dispersed throughout the central section of the corridor.

5.3.4 Future investigations

Planning for future road development in the corridor will require more detailed geotechnical assessment, looking specifically at route options and involving more detailed site reconnaissance. Specific geotechnical testing will also be required. Recreational canyons will need to be considered in any route development work and assessment.
Figure 5.2
Geotechnical constraints
5.4 Ecology

The Bells Line of Road corridor contains areas of exceptionally high ecological values. The ecology of the area is critical to the decision-making process for any future road upgrade.

Between Kurrajong Heights and Bell, the Bells Line of Road passes through the Greater Blue Mountains World Heritage Area with Wollemi National Park to the north and Blue Mountains National Park to the south. This central section features dense native vegetation with associated fauna.

In the eastern section, the surrounding area has been heavily cleared. However there are still large and significant remnant patches of native vegetation associated with various Endangered Ecological Communities on the Cumberland Plain and the escarpment near Kurrajong.

The western section features dense native vegetation, particularly along the Darling Causeway and Chifley Road.

5.4.1 Mapping methodology

The ecology constraint analysis was based on three aspects:

> Native vegetation.
> Endangered ecological communities.
> Riparian vegetation and aquatic habitats.

The following constraint classifications were used to develop the ecology constraints map:

**High constraint**

> Endangered ecological communities, un-fragmented native vegetation and riparian zone vegetation, and significant aquatic habitats.

**Moderate constraint**

> Fragmented native vegetation that is not an endangered ecological community.

**Low constraint**

> Areas not containing native vegetation.

5.4.2 Community input

Numerous comments were received from the community about the ecology, flora and fauna of the corridor. There was substantial concern about the potential impacts on vegetation and threatened and endangered species if future road development were to occur. The following areas, species and communities were specifically mentioned:

> Western Sydney dry rainforest.
> The flora and fauna of Botanist’s Way (a tourist drive that includes Bells Line of Road).
> Blue Mountains National Park.
> Hanging swamps on sandstone.
> Giant dragonfly habitat.
> Little Wheeny Creek – platypus, echidna, wallabies.
> Bellbird habitat.
> Small pockets of ecological communities on Bellbird Hill.
> Large trees, including *Eucalyptus deanei*, near Bilpin.
> Extensive corridor linkages between fauna populations in the Grose Wilderness and Wollemi National Park.
5 Constraint analysis

Figure 5.3
Ecological constraints
The Air Services Australia site, which the Castlereagh Road corridor passes through. This contains critically endangered vegetation communities, notably about 250 hectares of Cumberland Plain shale woodlands and Shale-Gravel transition forest and 111 hectares of Cooks River Castlereagh ironbark forest, mostly in good condition and free of weeds. This site also contains habitat for a considerable number of bird species that are now rare and declining in the Sydney area.

Endangered ecological communities within the road reserve of the Bells Line of Road corridor.

In addition, many people who provided comments were concerned about the impacts of an upgraded road on the environment of the Blue Mountains and Wollemi national parks. These concerns related to:

- Negative impacts on tourism, cultural heritage, endangered shale forest communities and upland swamps.
- Possible loss of National Park land.
- Permanent damage to the Greater Blue Mountains World Heritage Area, two wilderness areas and the Wollemi and Blue Mountains national parks, including impacts on the Wollangambie and Grose rivers.

5.4.3 Mapping results

Ecological constraints are shown in Figure 5.3.

High constraint areas

- There are extensive areas of high ecological constraint within the Bells Line of Road corridor. This reflects the native vegetation communities associated with the Blue Mountains and Wollemi national parks (including endangered ecological communities, especially on the Cumberland Plain), riparian ecology, and state forests in the central and western areas.

Moderate constraint areas

- Areas of moderate constraint reflect areas of fragmented vegetation communities. These are isolated in small concentrations, particularly south of Richmond on the Cumberland Plain and within the Hartley Valley.

Low constraint areas

- Areas of lower constraint are generally seen in areas where vegetation has been disturbed by urban development (eastern section) and rural development (central and western sections).

5.4.4 Future investigations

Any future road planning and design will require detailed ecological studies. More targeted mapping and species identification will be required in relation to:

- Extent and condition of vegetation, particularly endangered ecological communities.
- Presence and location of threatened and other significant flora species.
- Actual and potential presence of threatened and other significant fauna species.
- Presence of endangered ecological communities, as listed under NSW and/or Commonwealth legislation.
- Extent of wildlife movement corridors.
- Types and location of quality habitat.
- Condition and extent of aquatic habitats and species.
5.5 Landscape character

Landscape character is the aggregate of built, natural and cultural aspects that make up an area and provide its unique sense of place.

The Bells Line of Road corridor offers areas of visual richness and a diverse range of experiences. These qualities are a function of climate, topography characterised by major changes in elevation and dramatic landforms, cultural and heritage items, and the close proximity of unique vegetation. The corridor includes the Wollemi and Blue Mountains national parks and the Hawkesbury River.

At both ends of the corridor are established towns with embodied European heritage, the Macquarie towns of Richmond and Windsor at the outer extent of Sydney’s metropolitan footprint in the east and Lithgow in the west.

5.5.1 Mapping methodology

The landscape constraint analysis was based on the following characteristics of the landscape alongside the corridor:

- Geology
- Topography
- Culture
- Economy
- Transport environment
- Land use
- Pedestrian/cycle amenity
- Vegetation
- Hydrology
- Views
- Built form

The corridor was divided into two broad categories (urban and wilderness) which were then broken into further discrete landscape characters.

Landscape character types

Along the length of the route there are two broad landscape categories:

- Urban/rural/settled landscapes clearly modified for human use or habitation.
- Wilderness landscapes, mostly undisturbed bushland or forest.

At a more detailed level, the corridor contains 17 discrete landscape character types. Each was assigned a constraint level (high, moderate, low) based on its sensitivity to any road upgrades. The character types and constraint level classifications are summarised in Table 5.2.
## Table 5.2 Landscape character types

<table>
<thead>
<tr>
<th>Character type</th>
<th>Constraint level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Established suburban</td>
<td>High</td>
<td>Larger areas of residential land (plus schools, shops, etc), mainly in north-western Sydney, Kurrajong and Lithgow.</td>
</tr>
<tr>
<td>Mountain village</td>
<td>High</td>
<td>Urban centres in the central section that form a service base with schools, post offices, accommodation, general stores, etc.</td>
</tr>
<tr>
<td>High street civic</td>
<td>High</td>
<td>Established centres that serve a civic function (e.g., local council chambers, police stations, courthouses, commercial and retail).</td>
</tr>
<tr>
<td>Forest ridgeline</td>
<td>High</td>
<td>Areas where Bells Line of Road is on a ridgeline with forest immediately adjacent to the corridor, with very few built elements.</td>
</tr>
<tr>
<td>Mountain pass</td>
<td>High</td>
<td>Areas along the road corridor associated with sharp changes in elevation and winding routes that provide a constantly changing visual experience.</td>
</tr>
<tr>
<td>Forest flood plain</td>
<td>High</td>
<td>Flood plain areas with remnant or regrowth forest and agricultural land. The suitability of much of the surrounding land for agriculture means that large areas of this character type are rare.</td>
</tr>
<tr>
<td>Forest mountain/national park</td>
<td>High</td>
<td>Areas in the central section with native vegetation, either untouched or regrowth forest. Spatial quality is enclosed.</td>
</tr>
<tr>
<td>River/riparian</td>
<td>Moderate</td>
<td>Areas where a watercourse (e.g., Hawkesbury River) is large enough to have a visual presence as well as offering recreational opportunities such as water-skiing or parkland on its banks.</td>
</tr>
<tr>
<td>Mountain rural</td>
<td>Moderate</td>
<td>Rural properties above the escarpment mainly in the central section, and, to a lesser extent, in the western section.</td>
</tr>
<tr>
<td>Rural escarpment</td>
<td>Moderate</td>
<td>The area above the Hawkesbury River beyond North Richmond, characterised by a repeating pattern of agricultural land, residential areas, small shopping centres and remnant vegetation.</td>
</tr>
<tr>
<td>Rural valley</td>
<td>Moderate</td>
<td>The area between Great Western Highway and the base of the ridges. Contains Newnes Plateau, Darling Causeway and Chifley Road, and comprises rural residential land and small village centres.</td>
</tr>
<tr>
<td>Institutional</td>
<td>Moderate</td>
<td>Department of Defence land, universities, TAFEs and other institutional land.</td>
</tr>
<tr>
<td>New growth area residential</td>
<td>Low</td>
<td>Future land release areas within the North West Growth Centre.</td>
</tr>
<tr>
<td>Rural flood plain</td>
<td>Low</td>
<td>Rural areas in the South Creek–Hawkesbury River flood plain area. Includes agriculture and related businesses such as agricultural and landscape supplies, as well as some concentrated recreational areas.</td>
</tr>
<tr>
<td>Combined road/rail corridor</td>
<td>Low</td>
<td>Where road and rail corridors run parallel and within visual proximity of each other.</td>
</tr>
<tr>
<td>Commercial/retail</td>
<td>Low</td>
<td>Areas with commercial and retail activity, generally located in areas of higher residential density.</td>
</tr>
<tr>
<td>Industrial</td>
<td>Low</td>
<td>Industrial land, including mining. Use tends to be concentrated on the floodplain and around Lithgow.</td>
</tr>
</tbody>
</table>
Legend

- Bells Line of Road
- Ecological Constraints
- Motorway
- High Constraint
- Moderate Constraint
- Low Constraint
- Major Roads
- Rivers
- Extent of Mapping

Figure 5.4
Landscape character constraints
5.5.2 Community input

Many community members living in the Bells Line of Road corridor expressed concerns about:

> Potentially losing the unique character of the area if major road upgrades were to occur. The rural lifestyle, the agricultural land and country atmosphere were viewed as contributors to the tourist economy, and were highly valued lifestyle factors.

> The potential for communities to be physically divided should a major road upgrade be built.

5.5.3 Mapping results

Landscape character constraints are shown in Figure 5.4.

High constraint areas

> Areas in close proximity to the unique vegetation of the Wollemi and Blue Mountains national parks and the Hawkesbury River.

> Areas in the central section, mainly due to the sensitivity of the ‘forest mountain’ character zone and regular occurrence of mountain villages.

> The established towns with embodied European heritage – the Macquarie towns of Richmond and Windsor in the east and Lithgow in the west – at both ends of the corridor.

Moderate constraint areas

> The majority of the rural areas west of the Hawkesbury River.

Low constraint areas

> Areas of low constraint occur where the built environment will change in the future in the North West Growth Centre.

5.5.4 Future investigations

When planning for future road upgrades, detailed urban design investigations will be required. An urban design framework for the corridor should be developed to incorporate the following objectives:

> Urban structure: Maintain and enhance the urban structure of settlements that occur along the corridor.

> Existing communities: Maintain and enhance the integrity of Blue Mountains and Cumberland Plain communities that contribute to the unique character of the corridor.

> Cultural elements: Maintain and enhance those cultural elements within the corridor that contribute to the unique character of Bells Line of Road.

> Natural features: Maintain and enhance the existing natural features within the corridor that contribute to its unique visual and landscape character.

> Landscape value: Maintain and enhance the World Heritage and Blue Mountains National Park landscape that contributes to the unique visual and landscape character along the corridor.

> Views: Maintain and enhance short and long distance views, within the corridor and from surrounding major vantage points, that contribute to the unique visual character of the Bells Line of Road corridor.

> Planning: Use the urban, landscape and visual assessment process to assist the selection and planning of the corridor.
5.6 Visual character

Constraints associated with visual character differ from landscape character in that they relate to the change to the landscape that would be visually perceivable as a result of new road development, rather than potential impacts on the broader urban and rural fabric.

The Bells Line of Road corridor contains dramatic visual landscape associated with the national parks, changes in elevation and a range of visually sensitive land uses.

5.6.1 Mapping methodology

The visual constraint analysis evaluated the likely visual sensitivity of any upgrade(s) of Bells Line of Road. The analysis considered three main inputs representative of the visual character of the corridor – land use, native vegetation and slope. These inputs were considered separately in the visual analysis and combined in an overall visual character constraint map.

Land use

Land use was used as an indicator for the location of viewers and to help assess land use sensitivity to possible future road upgrade(s). A higher constraint was given to areas with a higher number of viewers, where views are of a longer duration, and/or where the quality of views is particularly important, including the dramatic visual landscape of the Blue Mountains and Wollemi national parks.

High constraint

> Small rural lots (less than 10 hectares), rural, active fruit growing, flood plain agriculture and open space/environmental protection areas.

Moderate constraint

> Areas with commercial, special use/community, open space/recreation and residential land uses.

Low constraint

> Areas with industrial, military, infrastructure and forestry land uses.

Native vegetation

The clearing of native vegetation will generally result in changes to the landscape, such as scarring and/or changes to vistas.

High constraint

> Areas of native vegetation, particularly more densely forested areas.

Low constraint

> Areas with no native vegetation.

Slope

Slope has a correlation with earthworks volumes. Generally, the steeper the terrain, the greater the level of cut and fill required during construction, and the greater the potential change in the landscape.

High constraint

> Areas with a slope of greater than 15 per cent.

Medium constraint

> Areas with a slope of 5–15 per cent.

Low constraint

> Areas with a slope of 0–5 per cent.
5.6.2 Community input

Community input highlighted the importance of the scenic environment to the community. Specific comments related to views to and from Bells Line of Road, including views to orchards, the passage of road through a forested landscape and the importance of views to the cliffs and Grose Valley between Mount Tomah and Bell.

In addition, there were concerns about potential impacts of road upgrades on the scenic values of, and views from, the Grose and Wollemi wilderness areas within the Blue Mountains National Park and the highly scenic Gardens of Stone.

5.6.3 Mapping results

Visual character constraints are shown in Figure 5.5.

High constraint areas

> The visually dramatic bushland landscape within the national parks has great visual importance. Areas of high constraint are found predominantly in the central and western sections associated with the occurrence of native vegetation and high slopes of the Blue Mountains and Wollemi national parks.

Moderate constraint areas

> Areas of moderate constraint in the eastern section reflect the flatter, relatively less vegetated areas.
> Areas of moderate constraint in the western section are generally due to the presence of native vegetation.

Low constraint areas

> Areas of low constraint are largely to the east of the Hawkesbury River and reflect less visually sensitive land uses (eg rural settlement) and relatively flatter, cleared areas.

5.6.4 Future investigations

Visual character will change over time, depending on changes in adjoining land use and vegetation growth. Therefore, this analysis and mapping should be reviewed and updated as part of future investigations. A detailed visual impact assessment will need to be undertaken in relation to planning for any future road development in the corridor.
Figure 5.5
Visual constraints
5.7 Aboriginal heritage

There is a rich heritage of Aboriginal occupation in the Bells Line of Road corridor. The widely varying topography and environment, however, resulted in different patterns of use by Aboriginal people.

Aboriginal heritage is understood to varying degrees across the Bells Line of Road corridor. The eastern section has been well studied over the last 20 years. However, there is an absence of baseline information for the central and western sections, which means that these areas are relatively poorly understood archaeologically.

5.7.1 Mapping methodology

The Aboriginal heritage constraint analysis aimed to show areas of the corridor more likely to have had Aboriginal occupation. These are considered to have a higher sensitivity to upgrade(s) of Bells Line of Road, and therefore were rated with a higher constraint.

Due to the different land uses and differences in topography between the east and west of the Hawkesbury River, two different occupation models were developed:

> East of the Hawkesbury River on the Cumberland Plain, the corridor is characterised by flatter, more disturbed flood plain. Vegetation is more fragmented than to the west of the river, reflecting the influence of rural and residential land uses. The eastern occupation model for the Cumberland Plain considers the following factors and the interaction between them: native vegetation, creeks and waterways, and disturbance. Aboriginal occupation and the preservation of any artifacts is considered more likely along waterways and within areas of undisturbed native vegetation.

> West of the Hawkesbury River, the corridor is characterised by the steeper, heavily vegetated land of the Blue Mountains. The western occupation model for the Blue Mountains considers the following factors: native vegetation, geology (ie the presence of Hawkesbury Sandstone), creeks and waterways, and slope. Similar to the eastern model this model considers that Aboriginal occupation and the preservation of any artifacts is more likely along waterways and within areas of undisturbed native vegetation. Additional factors of slope and geology have been included in the western model to take into account accessibility and transversibility of steep terrain and that certain geologic layers have a greater likelihood of formation of rock shelters and surfaces suitable for engraving.

High, moderate and low constraints for each of the above factors have been identified. Inputs into the two occupation models are listed below:

**Cumberland Plain (east of Hawkesbury River)**

**High constraint:**
> Native vegetation within 100 metres of a creek or waterway.

**Moderate constraint:**
> Native vegetation greater than 100 metres from a creek or waterway.

**Low constraint**
> Land without native vegetation – that is, cleared land.

**Blue Mountains (west of Hawkesbury River)**

**Native vegetation**

**High constraint:**
> Areas of native vegetation.
5 Constraint analysis

Low constraint:
> Un-vegetated areas – that is, cleared land.

Geology

High constraint:
> Hawkesbury Sandstone, which has a greater likelihood of formation of rock shelters and surfaces suitable for engraving.

Low constraint:
> Geology that is not Hawkesbury Sandstone.

Waterways

High constraint:
> Land within 100 metres of creek or waterway.

Low constraint:
> Land greater than 100 metres from creek or waterway.

Slope

High constraint:
> Land where slope is less than 20 per cent.

Low constraint:
> Land where slope is greater than 20 per cent.

5.7.2 Community input

Aboriginal cultural heritage and its preservation was of interest to the wider community. A number of specific areas were suggested as having potentially significant cultural heritage value and recommended for investigation during planning for the corridor. Specific input and concerns relating to Aboriginal cultural heritage and its need for preservation included:

> Bells Line of Road – considered to be used as an ancient footpath by Aboriginal people.
> Dharug and Wiradjuri associations – from North Richmond to Bell.
> Aboriginal land claims – particularly east of the Hawkesbury River.

5.7.3 Mapping results

Aboriginal heritage constraints are shown in Figure 5.6.

High constraint areas
> High constraint is restricted to small, concentrated areas, particularly in the central region, associated with the occurrence of Hawkesbury Sandstone and accessible areas along drainage lines. High constraint is strongly influenced by the occurrence of creeks and vegetation, especially within the eastern section.
> In the more mountainous areas to the west of the Hawkesbury River, where slope has a greater influence, dispersed areas of high constraint occur due to the occurrence of waterways, Hawkesbury Sandstone and lower slope.

Moderate constraint areas
> Concentrated areas of moderate constraint are dispersed throughout the eastern, central and western sections of the corridor. These correspond with drainage lines and creeks, especially west of the Hawkesbury River, as well as vegetated areas, slope and geology.
Aboriginal heritage constraints

Figure 5.6
Low constraint areas

> Low constraint is dispersed throughout the corridor. East of the Hawkesbury River, low constraint corresponds with land disturbed by rural and residential land uses. Within the Blue Mountains (west of the Hawkesbury River) low constraint areas correspond to particularly high-slope areas, reflecting less accessible areas.

5.7.4 Future investigations

The limited information available on Aboriginal cultural heritage sites, together with the importance of this area indicates a need for a detailed, site-specific assessment of Aboriginal heritage as part of any future investigations. This would include targeted surveys and consultation with the Aboriginal community.
5.8 Non-Aboriginal heritage

The Bells Line of Road corridor and townships of the area have a rich cultural heritage, associated with exploration and settlement within the mountains. Non-Aboriginal heritage sites include sites of State, regional and local significance. The Greater Blue Mountains World Heritage Area, which is listed on the World Heritage and National Heritage registers, is also included in the constraints mapping.

5.8.1 Mapping methodology

The constraint classifications for the non-Aboriginal heritage analysis are based on a search of currently listed sites within the corridor. Constraint classifications are:

**High constraint**
- > Any listed site of State, regional and local significance, and any listed site on the World Heritage List or National Heritage List and identified historic trails.

**Moderate constraint**
- > Not considered.

**Low constraint**
- > No listed sites.

5.8.2 Community input

The community expressed a preference to preserve non-Aboriginal heritage items during any future plans for the road corridor. A number of specific areas were suggested as having heritage value and recommended for investigation during planning for the corridor. The community identified the presence of a number of heritage items and associations, including:

> The presence of colonial architecture and convict relics along and near the existing route.
> The use of Bells Line of Road as a major stock route and a walkway to the western goldfields, and its connections to scientific and botanical explorations.
> The road at North Richmond, Kurrajong Heights and Mount Tomah and its connections with early explorations from 1793 to 1823.
> Associations with explorers Matthew Everingham, George Caley and Archibald Bell Jr, after whom Bells Line of Road was named.
> History associated with 19th century botanist and natural historian Louisa Atkinson, who at one time resided in Kurrajong Heights, where she gathered and painted flora and fauna.

5.8.3 Mapping results

Non-Aboriginal heritage constraints are shown in Figure 5.7.

**High constraint areas**
- > The largest concentration of high constraint is located in the central section, and is attributed to the Greater Blue Mountains World Heritage Area.
- > Items of high constraint (heritage listed sites) are dispersed throughout the study area, associated with individual sites within townships and suburbs.
- > The more substantial clusters of individual sites are found around the larger and older centres of occupation – Kellyville, Rouse Hill, Riverstone, Agnes Banks, Castlereagh, Kurrajong, Kurrajong Heights, Hartley, Lithgow and, particularly, Richmond and Windsor. Sites are also located at Mount Victoria and Mount Wilson.
Figure 5.7
Non-Aboriginal heritage constraints
Low constraint areas

> Generally, non-Aboriginal heritage is a low constraint across the eastern and western areas of the corridor.

5.8.4 Future investigations

The constraint mapping provides a general overview and does not include all listed sites, due to some listings lacking specific location data. There are also likely to be a large number of unlisted sites with heritage significance occurring within the corridor. Future detailed investigations would need to identify these.

Any future upgrade to Bells Line of Road will also require consideration of sites that are currently nominated for listing on the statutory registers. Such items/sites include the Blacktown Native Institution and the Colebee/Nurragingy Land Grant nominations on the State Heritage Register and the Hartley Valley, which is currently nominated for listing on the National Heritage List.

Additionally, future planning will also need to consider the heritage listed walking trails (there are more than 300 trails) of the Blue Mountains World Heritage Area.

Fieldwork will need to be undertaken as part of future planning. It is expected that the number of potential heritage items and archaeological sites will increase after detailed historical analysis and a site survey are undertaken. More detailed investigations will need to consider both direct and indirect impacts on heritage items, and consider design measures to minimise any impacts.
5.9 Water quality

Bells Line of Road lies within the Hawkesbury–Nepean River Catchment, one of the most important rivers in the greater Sydney area. The Hawkesbury–Nepean River system provides drinking water for Sydney, the Blue Mountains and the Illawarra, and water for agriculture and coal-mining operations. It also supports commercial and recreational fishing. In addition, the corridor includes the ‘wild river’ catchments of the Grose and Colo rivers (as defined by the National Parks and Wildlife Act 1974). Wild river declaration provides a high level of protection and conservation to some of the least disturbed watercourses in NSW. Water quality protection is particularly important in these areas.

5.9.1 Mapping methodology

The water quality constraint analysis focused on mapping watercourses and sensitive catchments with the potential to be affected by road upgrade(s). Sensitive catchments were identified as drinking water catchments and the ‘wild river’ catchments of the Grose and Colo rivers.

Buffers were established around the watercourses to quantify areas of constraint. For the purposes of identifying the importance of potential water quality impacts and the risks to any upgrade(s), the following classifications were used.

High constraint
> Less than 50 metres from a watercourse.

Moderate constraint
> Within 50–100 metres of a watercourse.
> Within a wild rivers catchment, for the Grose or Colo rivers.
> Within a drinking water catchment.

Low constraint
> Greater than 100 metres from a watercourse and outside a wild rivers or drinking water catchment.

5.9.2 Community input

The community raised specific concerns about potential impacts on river systems and drinking water catchments. Specific comments included concerns about:
> Impacts on the Wollangambie and Grose rivers.
> A possible Lithgow bypass (potentially associated with an upgrade of the Bells Line of Road corridor). It was commented that this could impact on Lithgow’s drinking water supply.
> The need to protect dams in the keyline dam system, directly west of North Richmond. These dams will need to be considered in planning any upgrade(s) to the Bells Line of Road.

5.9.3 Mapping results

Water quality constraints are shown in Figure 5.8.

High constraint areas
> High constraint areas include watercourses, such as the Hawkesbury River and water courses feeding this and the Grose and Colo rivers. These high constraint areas correspond directly to watercourses, where the potential impacts on water quality are considered the highest.
Figure 5.8
Water quality constraints
Moderate constraint areas
> The large proportion of moderate constraint areas in the central and western sections reflects the occurrence of drinking water and the catchments of the Grose and Colo rivers (which are classified as wild rivers). The moderate constraints do not relate directly to watercourses but rather the catchments which feed them.

Low constraint areas
> Low constraint areas dominate the eastern section of the corridor, as there are no specific catchments in this area.

5.9.4 Future investigations
Any planning for future upgrade(s) must consider potential impacts on both the wild river and drinking water catchments, which are protected by State legislation and planning policies. Similarly, development within a drinking water catchment must demonstrate neutral or beneficial effects on water quality.

Any road development in the corridor will require a site-specific soil and water management plan to address construction phase water quality and may require water quality monitoring to be undertaken.

Water quality will also be an important component of the design of any future road development due to the need to avoid road contaminants entering sensitive waterways as a result of road operation. Planning and design will need to consider spill containment and the quality of day-to-day road runoff.
5.10 Flooding

Major waterways within the study area include the Hawkesbury, Grose and Colo rivers and their tributaries.

Historically, flooding associated with the Hawkesbury River has been a concern, with flood immune access and flood evacuation routes an important consideration.

5.10.1 Mapping methodology

The flooding constraint analysis focused on the Cumberland Plain and flooding associated with the Hawkesbury River. Flooding was not considered a key constraint in the more mountainous areas. The constraints classifications were based on the 1 in 100 year flood event of the Hawkesbury River. The following constraints classifications were used:

High constraint
> No high constraint was applied as flooding issues can to some extent be addressed in road design.

Moderate constraint
> Within the 1 in 100 year flood level for the Hawkesbury River.

Low constraint
> Outside the 1 in 100 year flood level for the Hawkesbury River.

5.10.2 Community input

Community comments about flooding were in relation to the provision of a flood-free access from Bells Line of Road across the Hawkesbury flood plain.

5.10.3 Mapping results

Flooding constraints are shown in Figure 5.9.

High constraint areas
> There are no areas of high constraint.

Moderate constraint areas
> Areas of moderate constraint are restricted to the Cumberland Plain.

Low constraint areas
> Flooding is a low constraint along most of the corridor.

5.10.4 Future investigations

Hydrological modelling will be required in the planning phase of any future road development in the corridor. The provision of flood immunity will also need to be considered.

Consideration of other modelled flood levels other than the 1 in 100 year event will also be important in future planning and design, including the probable maximum flood event, as well as smaller (higher recurrence interval) events.

Rural land use on the Hawkesbury River flood plain
Figure 5.9
Flooding constraints
5.1.1 Noise

Noise sources in the vicinity of the Bells Line of Road corridor include motor vehicles, residential properties, farming and agricultural activities, and some commercial and industrial activities. The noise environment varies along the corridor, as do the number, type and proximity of ‘noise-sensitive receivers’ to potential noise sources. Noise-sensitive receivers are defined as those human activities and locations that would be likely to be impacted by an increase in noise. Within the corridor, these include residences, schools, places of worship, hospitals, aged-care facilities and other community facilities.

5.1.1.1 Mapping methodology

The noise constraint analysis focused on the location of noise-sensitive receivers. These receivers were identified through aerial photography and other mapping sources.

**High constraint**
> Within 30 metres of a sensitive receiver.

**Moderate constraint**
> Between 30 and 150 metres of a sensitive receiver.

**Low constraint**
> Greater than 150 metres from a sensitive receiver.

5.1.1.2 Community input

Noise issues raised by the community included:
> The importance of a quiet environment to the community, particularly in residential areas.

> Concerns about noise created by trucks and motorbikes using Bells Line of Road. Truck noise was reported to be very loud at night, and motorbikes were reported to cause a noise nuisance on weekends.

> Concern that an increase in traffic, especially heavy vehicles and construction vehicles, could increase noise and intrude on the bush and recreational experiences on Bells Line of Road.

5.1.1.3 Mapping results

Noise and vibration constraints are shown in Figure 5.10.

**High and moderate constraint areas**
> High and moderate constraint areas are dispersed throughout the corridor and reflect the urban and rural settlement pattern.

> The concentrated areas of high constraint reflect the denser areas of urban residential settlement of Richmond, Windsor, Quakers Hill and surrounding suburbs, as well as Kurrajong, Kurrajong Heights and Lithgow.

**Low constraint areas**
> Noise and vibration are generally a low constraint along the majority of the corridor, due to the large areas of bushland along the corridor. The concentrations of sensitive receivers are associated with the existing road network.

5.1.1.4 Future investigations

A site-specific noise and vibration study will be needed as part of planning for any specific future upgrade. Noise modelling may be required depending on the type and location of future road development. A noise and vibration management plan may be required for future construction works and operation of the Bells Line of Road.

New growth areas in western Sydney will be sensitive to traffic noise.
5.12 Air quality

Air quality in the corridor is influenced by the Sydney Basin airshed, as well as, more locally, the level of motor vehicle emissions, domestic solid-fuel heaters, some rural and agricultural land uses, and industrial and commercial activities. The existing air quality is likely to vary along the corridor based on proximity to major roads and to other sources of air pollution, as are the number, type and proximity of sensitive receivers that could potentially be affected by any change in air quality during the construction or operation of any future road upgrade(s).

5.12.1 Mapping methodology

Sensitive receivers were identified based on existing mapping and analysis of aerial photography. From an air quality perspective, sensitive receivers are generally located close to the existing road network. Within the corridor, these include residences, schools, places of worship, hospitals, aged-care facilities and other community facilities.

The following buffer thresholds were applied for the air quality constraints map based on typical dispersion patterns of pollutants associated with major roads.

High constraint
> Within 10 metres of sensitive receptors.

Moderate constraint
> Between 10 to 40 metres of sensitive receivers.

Low constraint
> Greater than 40 metres from sensitive receivers.

5.12.2 Community input

Community concerns and feedback to date relating to air quality impacts were limited. While not strictly an air quality issue, specific concerns were raised regarding increases in greenhouse gas emissions as a result of increased traffic.

5.12.3 Mapping results

Air quality constraints are shown in Figure 5.11.

High and moderate constraint areas
> Areas of high and moderate constraint reflect the settlement patterns of urban and rural residential areas.
> More concentrated areas of high constraint in the eastern and western sections reflect the denser urban areas.

Low constraint areas
> Air quality is a low constraint along the majority of the corridor because of the distribution of sensitive receptors and the generally small area of potential impact associated with air quality from roads in a rural environment.

5.12.4 Future investigations

A site-specific air quality study may be required for future road development. This may require modelling of air quality impacts if projected traffic volumes and the proximity of sensitive receivers warrant this.
Figure 5.11
Air quality constraints
5.13 Overview of constraints

A combined constraints map was prepared from the 11 environmental, social and technical factors presented above. Equal weighting was given to all factors at this point of development. The combined map (Figure 5.12) shows areas of higher and lower constraint on a graduated scale.

Higher constraint areas

> Areas of higher constraint in the eastern section are generally associated with urban and vegetated areas.
> Generally, the higher constraint areas are within the central section, associated with the steeper and more vegetated land of the Greater Blue Mountains World Heritage Area (Blue Mountains and Wollemi national parks).
> Areas of high constraint in the western section correspond to urban areas as well as specific land uses, including mining and defence land.

Moderate constraint areas

> Areas of more moderate constraint include vegetated areas outside the World Heritage boundaries and some smaller lot rural areas and larger lot rural areas with steeper terrain.

Lower constraint areas

> Areas of lower constraint are generally associated with the rural, un-vegetated, flatter areas of the eastern and western sections.
> Lower constraint in the central section generally corresponds with areas directly adjacent to the Bells Line of Road.

This constraint analysis suggests that any major road upgrade through the central and western parts of the Bells Line of Road corridor would be extremely challenging from an environmental, approvals and cost perspective.

This area (particularly the central section) includes the Greater Blue Mountains World Heritage area which has a wide range of ecological and cultural values. It also coincides with challenging terrain which would be likely to add greatly to the cost of construction (refer to Section 5.3 Geotechnical constraints). Any major road upgrade through this area would require an extremely strong justification in terms of community need and economic benefit to counter the potential environmental and social impacts.

There are more opportunities for new road development in the eastern section than in the central and western sections. In this section there are areas of lower environmental value and terrain that are generally more conducive to road construction. One major challenge in this area is increasing urbanisation in western Sydney, which will gradually increase the level of constraint on new road development. Early planning for any future road development in this area will maximise opportunities to integrate the road development into future urban areas, minimising its impact to those communities.
5 Constraint analysis

Combined constraints

Legend
- Bells Line of Road
- Motorway
- Major Roads

Composite Constraints
- Higher constraint
- Lower constraint

Figure 5.12
Aerial Photo 2010
ARUP, RTA 2011
Data Source:

J:\220904 BLOR\04-00_Arup Project Data\04-07_GIS\projects\Constraints\Composite Constraints.mxd

© Arup

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6 Engineering analysis

This chapter presents the engineering analysis of the Bells Line of Road and Chifley Road between North Richmond and Lithgow. It provides an assessment of the physical characteristics and recent crash history of the road.

6.1 About the engineering analysis

Extent of the engineering analysis

The condition of the existing Bells Line of Road corridor was evaluated from North Richmond to the Great Western Highway at Lithgow. This comprises Bells Line of Road and Chifley Road.

The corridor east of the Hawkesbury River comprises the broader road network between Bells Line of Road and the Sydney motorway network and is relevant to the Plan from the broad perspective of efficient connections. Traffic capacity of the road corridor is the main constraint east of the Hawkesbury River and the Plan is not focused on identifying improvements to the condition of the road network in this section.

How the Bells Line of Road is classified

The Bells Line of Road is classified as a 'main road' under the NSW Roads Act 1993 and as a 'State road' by RMS (RMS classifies all roads as either State, regional or local roads). State roads are the major arterial links throughout NSW and within major urban areas. They include the main traffic-carrying and linking routes that connect the major urban centres such as Sydney and Newcastle, and the State’s major regional towns.

The Federal Government has an involvement on those State roads which are defined under federal legislation as part of the National Land Transport Network, but Bells Line of Road is not part of this network.

Road corridor sections

To facilitate the analysis, the length of the corridor between North Richmond and Lithgow was divided into 18 sections based on characteristics such as terrain, land use, environment and road conditions, each section having relatively similar characteristics. These sections are listed in Table 6.1 and shown in Figure 6.1.

The engineering analysis was undertaken using data generated from RMS’ computer-based Gipsicam mobile mapping system, which enables existing road characteristics to be assessed at a level of accuracy appropriate for a strategic assessment.

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Distance (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>North Richmond, between the Hawkesbury River Bridge to Grose Vale Road</td>
<td>0.8</td>
</tr>
<tr>
<td>2</td>
<td>Grose Vale Road, North Richmond to Kurmond Road, Kurmond</td>
<td>4.3</td>
</tr>
<tr>
<td>3</td>
<td>Kurmond Road to Comleroy Road, Kurrajong</td>
<td>1.7</td>
</tr>
<tr>
<td>4</td>
<td>Comleroy Road to Kurrajong Heights, including Bellbird Hill</td>
<td>6.1</td>
</tr>
<tr>
<td>5</td>
<td>Kurrajong Heights to Bilpin Public School</td>
<td>11.9</td>
</tr>
<tr>
<td>6</td>
<td>Bilpin Public School to Berambling Crescent</td>
<td>9.7</td>
</tr>
<tr>
<td>7</td>
<td>Berambling Crescent to north-eastern part of Mount Tomah Botanic Garden</td>
<td>2.9</td>
</tr>
<tr>
<td>8</td>
<td>West of Mount Tomah Botanic Garden</td>
<td>3.4</td>
</tr>
<tr>
<td>9</td>
<td>Blue Mountains National Park</td>
<td>5.9</td>
</tr>
<tr>
<td>10</td>
<td>Blue Mountains National Park to East of Mount Wilson Road</td>
<td>4.2</td>
</tr>
<tr>
<td>11</td>
<td>West of Mount Wilson Road to the Darling Causeway at Bell</td>
<td>7.4</td>
</tr>
<tr>
<td>12</td>
<td>Darling Causeway at Bell to Valley View Road at Dargan</td>
<td>3.1</td>
</tr>
<tr>
<td>13</td>
<td>Valley View Road at Dargan to railway underpass at Newnes Plateau</td>
<td>3.2</td>
</tr>
<tr>
<td>14</td>
<td>Railway underpass at Newnes Plateau to next railway underpass near Zig Zag Railway</td>
<td>4.1</td>
</tr>
<tr>
<td>15</td>
<td>Railway underpass near Zig Zag Railway to Hartley Valley Road, Corney Town</td>
<td>5.4</td>
</tr>
<tr>
<td>16</td>
<td>Hartley Valley Road to Eddy Street, Lithgow</td>
<td>0.8</td>
</tr>
<tr>
<td>17</td>
<td>Eddy St to Main Street, Lithgow</td>
<td>1.4</td>
</tr>
<tr>
<td>18</td>
<td>Main Street to Great Western Highway, Bowenfels</td>
<td>1.7</td>
</tr>
</tbody>
</table>
Figure 6.1
Location of road sections
6.2 Key road characteristics

The condition of the road corridor was assessed based on the key desirable road characteristics for a State road as presented in the *Austroads Guide to Road Design* (2011) and *RMS Supplements to the Austroads Guide* (2011). These road standards refer to:

- Speed zones
- Lane widths
- Sealed shoulders
- Grades (slopes)
- Curve radii
- Sight distances
- Clear zones
- Overtaking opportunities
- Rest opportunities

These standards are explained below, and the current condition of the Bells Line of Road is assessed against these standards, where applicable.

It should be noted that the guidelines described below have generally been developed for application to the design and construction of new roads or major upgrades of existing roads. While existing roads would not normally be expected to fully comply with these guidelines, the standards nevertheless provide an indication of the priorities that might be applied to future upgrades and interim works.

It is also noted that for lane widths, shoulder widths and clear zone widths the assessment was based on widths estimated from the Gipsicam video data rather than on-site measurements.

6.2.1 Speed zones

In determining the appropriate signposted speed limit for a section of road, a number of factors are taken into account, including the relative safety of a length of road, the road’s function and whether it is in a rural or urban environment.

**Road design recommendations**

Speed limits are recommended and signposted by RMS based on the *NSW Speed Zoning Guidelines* (RMS 2011). These posted speed limits, along with advisory signage, help motorists adjust to the road and drive at a safe speed appropriate to the conditions.

**Current situation**

RMS rationalised the speed limit zones for part of the Bells Line of Road corridor in October 2008. The reductions provide more consistency in the speed limits along this 78 kilometre length and rationalised the number of speed limit zones along the Bells Line of Road from 22 zones to 18 zones.

The majority of the speed limit zone changes concentrated on removing the 70 kilometre per hour and 90 kilometre per hour zones and reducing them to 60 kilometre per hour and 80 kilometres per hour zones respectively. There were also a number of short 100 kilometre per hour speed limit zones reduced to 80 kilometres per hour. The changes to the speed limit zones came into effect in October 2008.

**Figure 6.2** shows the current signposted speed limits.

**Speed zone characteristics for the Bells Line of Road include:**

- There is only one short section, east of Bell, that has a posted speed limit of 100 kilometres per hour.
- Most central sections have a speed limit of 80 kilometres per hour.
Figure 6.2
Posted speed limits
The sections east of Bilpin have a speed limit of mostly 60 kilometres per hour with some 80 kilometre per hour sections.

The sections west of Scenic Hill in Lithgow have a speed limit of 50 kilometres per hour.

The route has a number of school zones where the speed limit drops to 40 kilometres per hour from 8:00–9:30am and 2:30–4:00pm on gazetted school days.

In seven sections, the speed limit changes between 60 kilometres per hour and 80 kilometres per hour within the section.

6.2.2 Lane widths

Narrow lanes reduce the lateral clearance between vehicles, which reduces safe travel speeds and road capacity. Narrow lanes are more of a concern when combined with narrow shoulders, tight horizontal curves and steeper grades, and where the proportion of heavy vehicles is quite high, as is the case on the Bells Line of Road.

Road design recommendations

RMS recommends 3.5 metre wide lanes for new two-lane two-way rural roads.

Current situation

Existing lanes on Bells Line of Road are generally narrower than the recommended width, typically 3–3.2 metres wide.

6.2.3 Sealed shoulders

Road shoulders improve road safety by extending the sealed pavement outside the edge of the lane. This allows drivers more width to manoeuvre safely. Together with the verge area, the shoulder also provides a refuge where vehicles can safely stop and be clear of traffic.

Road design recommendations

RMS recommends one metre wide sealed shoulders for new two-lane two-way rural roads where the Annual Average Daily Traffic (AADT) is 2000 vehicles per day or more.

Current situation

Using Gipsicam video footage the existing sealed shoulder widths have been assessed for each section. The proportion of each section where the width of sealed shoulders on the Bells Line of Road is less than one metre is shown in Figure 6.3. About 84 per cent of the route has sealed shoulders less than one metre wide; of this, 34 per cent has sealed shoulders less than 200 millimetres wide. Sections with around 50 per cent or more of the length having sealed shoulders less than 200 millimetres wide are the two Mount Tomah sections (7 and 8), the two Blue Mountains National Park sections (9 and 10), and the Darling Causeway to Newnes Plateau sections (14 and 15). These sections are generally mountainous with a narrow formation width where widening the shoulder would be likely to require extensive earthworks.

The remainder of the route (about 16 per cent) has a shoulder greater than one metre wide but very little of the rural two-lane two-way sections have the 2–3 metre desirable shoulder widths. The sections with shoulders wider than one metre are in the lower speed, urbanised sections of North Richmond (to the east) and Lithgow–Bowenfels (to the west).
Figure 6.3
Corridor performance - sealed shoulder widths

Key
- 0% of sealed shoulder
- Less than 1m*
- Between 0% and 70% of sealed shoulder less than 1m*
- Greater than 70% of sealed shoulder less than 1m*

*Widths estimated using Gipsam footage and are to be used for strategic discussion only
6.2.4 Grades

Steep grades (or slopes) are typically of most concern when combined with sharp horizontal curves as this contributes to increased safety risk. Steep grades also influence transport efficiency, particularly for heavy vehicles.

Road design recommendations

Both Austroads and RMS suggest a desirable maximum grade of seven per cent in rolling terrain for an operating speed of 80 kilometres per hour.

Both Austroads and RMS also acknowledge that it is desirable to limit the length of sections with steep grades so that a loaded truck can operate without an unreasonable reduction in speed. For sections of road with grades greater than those given in Table 6.2, Austroads recommends that a risk analysis to identify operational and safety effects should be undertaken to determine the most appropriate treatment.

Table 6.2 Desirable maximum grades

<table>
<thead>
<tr>
<th>Grade (%)</th>
<th>Length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2–3</td>
<td>1800</td>
</tr>
<tr>
<td>3–4</td>
<td>900</td>
</tr>
<tr>
<td>4–5</td>
<td>600</td>
</tr>
<tr>
<td>5–6</td>
<td>450</td>
</tr>
<tr>
<td>Greater than 6</td>
<td>300</td>
</tr>
</tbody>
</table>

Current situation

The Bells Line of Road features rolling and mountainous terrain with many locations where lengths of grades exceed the Austroads desirable maximum lengths for new roads. The steepest sections, where sustained grades in excess of 10 per cent extend for more than 300 metres, are at:

> Section 7 – Mount Tomah (1100 metres at 11 per cent).
> Section 8 – Mount Tomah (350 metres at 11.5 per cent)
> Section 9 – Blue Mountains National Park (300 metres at 10.0 per cent)
> Section 10 – Blue Mountains National Park (300 metres at 10.1 per cent)
> Section 15 – descent into Lithgow (375 metres at 10.0 per cent)
> Section 15 – descent into Lithgow (300 metres at 10.7 per cent)

The route is generally rolling terrain elsewhere. Grades do however fluctuate and exceed the Austroads recommendations both in terms of the maximum grades and the lengths of steep grades.

The steep sections mentioned above generally coincide with tight horizontal geometry, which may exacerbate the potential safety risk.

The measure of performance of the sections within the corridor was the proportion of the length of each section where the grade exceeds the desirable maximum grade of seven per cent in rolling terrain, as shown in Figure 6.4.

6.2.5 Curve radius

The curve radius of a road refers to how sharply curved the road is. The higher the speed of the road, the larger the curve radius needs to be. Tight curves at higher speeds can lead to an increase in the number of vehicles losing control and leaving the roadway.
Figure 6.4
Corridor performance – grades (greater than 7%)
Road design recommendations

Austroads guidelines for new roads recommend desirable minimum radius curves for a given design speed. The Austroads recommendations are shown in Table 6.3.

Table 6.3 Desirable minimum radius curves

<table>
<thead>
<tr>
<th>Operating speed (km/h)</th>
<th>Desirable minimum curve radius (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>85–95</td>
</tr>
<tr>
<td>80</td>
<td>190–230</td>
</tr>
<tr>
<td>100</td>
<td>410–440</td>
</tr>
</tbody>
</table>

Current situation

Curvature along the route was estimated from the Gipsicam data and can be summarised as follows:

> About two per cent of the length comprises curves with radii less than 95 metres (suitable for 60 kilometres per hour or less).

> About 15 per cent of the length comprises curves with radii less than 230 metres (suitable for 80 kilometres per hour or less).

> About 37 per cent of the length has curve radii less than 440 metres (suitable for 100 kilometres per hour or less).

The remaining 63 per cent of the length comprises curves with radii greater than 460 metres or lengths of straights between curves, where horizontal geometry is not a constraint on operating speeds.

Sections with the highest proportion of their length comprising curves with radii less than 230 metres based on available sight distance (suitable for 80 kilometres per hour or less) are:

> Section 4 – Comleroy Road to Peck Road in Kurrajong Heights, including Bellbird Hill (29 per cent of the section).

> Section 7 – North-eastern part of Mount Tomah (25 per cent of the section).

> Section 8 – South western part of Mount Tomah (51 per cent of the section).

> Section 9 – Blue Mountains National Park (26 per cent of the section).

> Section 10 – East of Mount Wilson Road, Blue Mountains National Park (23 per cent of the section).

> Section 15 – Newnes Plateau and Clarence (33 per cent of the section).

The measure of performance was the proportion of the length of each section which comprised curves suitable for 80 kilometres per hour or less, as shown in Figure 6.5.

6.2.6 Sight distances

Sight distance refers to the length of road that a driver can see ahead at any given point. It is mainly affected by crests (vertical curves), but can also be reduced by bends in the road (horizontal curves), particularly where there is vegetation or other restrictions close to the road on the inside of the curve.

The aim of providing adequate sight distance is to ensure that drivers are able to perceive potential hazards and react within sufficient time to be able to stop or otherwise avoid these hazards.
Figure 6.5
Corridor performance – curvature
Sight distance restrictions can also occur at intersections and driveways where vehicles trying to enter the main roadway are unable to see far enough in one or both directions to be able to safely turn onto or cross the road.

Road design recommendations
Austroads guidelines for sight distances include formulae for stopping sight distance and overtaking sight distance. Overtaking sight distance requirements are considerably greater than those for stopping sight distance, which is the normal minimum requirement. As an example of stopping sight distance guidelines, a motorist travelling at 80 kilometres per hour requires a stopping sight distance of 100 metres to react and stop on seeing a hazard on the roadway. At 60 kilometres per hour the stopping sight distance reduces to 60 metres.

Current situation
Some sections of the Bells Line of Road have a large proportion of their length affected by crest vertical curves which restrict sight distance.

Sections with the highest proportion of their length suitable for a design speed of 60 kilometres per hour or less based on available sight distance (but signposted at 60 kilometres per hour or more) are as follows:
> Section 4 – Comleroy Road to Peck Road in Kurrajong Heights, including Bellbird Hill (5 per cent of the section).
> Section 9 – Blue Mountains National Park (51 per cent of the section).
> Section 16 – Vale of Clwydd (21 per cent of the section).

Sections with the highest proportion of their length suitable for a design speed of 80 kilometres per hour or less (but signposted at 80 kilometres per hour or more) are as follows:
> Section 4 – Comleroy Road to Peck Road in Kurrajong Heights, including Bellbird Hill (28 per cent of the section).
> Section 8 – South-western part of Mount Tomah (51 per cent of the section).
> Section 9 – Blue Mountains National Park (21 per cent of the section).

6.2.7 Clear zones
A clear zone is a term used to describe an unobstructed, relatively flat area beyond the outer edge of the travelling lane that allows a driver to stop safely or regain control of their vehicle if it leaves the road. Adequate clear zones increase the likelihood that a vehicle that leaves the roadway can make a safe recovery rather than crash, and also mitigate the severity of crashes that do occur.

Road design recommendations
The clear zone distance is normally measured at right angles to the edge of the outer running lane and varies depending on traffic speed, the slope of the verge and the traffic volume.
For typical traffic volumes on the Bells Line of Road, and with a flat verge, the desirable clear zone recommended by RMS design guide supplements for a new road varies from three metres at 60 kilometres per hour to five metres at 80 kilometres per hour and nine metres at 100 kilometres per hour.

Current situation
Along the Bells Line of Road, clear zones are less than the desired width and obstacles such as trees and rock cuttings are often located too close to the outer edge of the travel lane.
The measure of performance was the proportion of the length of each section which has adequate clear zones for 60 kilometres per hour or less, as shown in Figure 6.6. The clear zone width of
Figure 6.6
Corridor performance – clear zones

**Key**
- Under 25% with a clear zone less than 3m
- Between 25% and 50% with a clear zone less than 3m
- Over 50% with a clear zone less than 3m
three metres or 60 kilometres per hour was chosen as a more representative indicator since the higher clear zone width of five metres for 80 kilometres per hour is rarely available on the Bells Line of Road corridor.

Sections with over 50 per cent of their length with a clear zone adequate for 60 kilometres per hour or less (but signposted at higher than 60 kilometres per hour) are as follows:

> Section 4 – Comleroy Road to Peck Road in Kurrajong Heights, including Bellbird Hill (62 per cent of the section).
> Section 6 – Bilpin Public School to Berambing Crescent (57 per cent of the section).
> Section 13 – Valley View Road at Dargan to railway underpass at Newnes Plateau (56 per cent of the section).

### 6.2.8 Overtaking opportunities

Overtaking opportunities are important on rural roads, especially in difficult topography with steep grades and tight curves.

Road design recommendations

Requirements for overtaking lanes including location, length and line marking vary according to particular site conditions. On two-lane two way roads, the availability of overtaking opportunities depends on sight distance and gaps in the opposing traffic stream. As opposing traffic volume increases, overtaking opportunities become restricted even if sight distance is adequate. On an existing road, overtaking opportunities can be increased either by improved alignment or by the provision of overtaking lanes. Both Austroads and RMS provide guidelines for assessing the need for overtaking lanes. For a road such as Bells Line of Road, RMS guidelines would typically recommend that overtaking lanes should be provided at spacings of 10–15 kilometres. For 80 kilometres per hour the RMS minimum recommended length of an overtaking lane is 600 metres.

Current situation

The Bells Line of Road corridor has difficult topography as well as a mix of traffic types and, therefore, desired speeds. However, there are long lengths in the central part of the corridor where there are no overtaking lanes. In particular, there is a 25 kilometre-long section between Kurrajong Heights and Mount Tomah where there is no overtaking lane in either direction.

Overtaking lane locations are shown in Figure 6.7.

### 6.2.9 Rest opportunities

Rest opportunities help drivers to manage fatigue. They are particularly important for drivers travelling longer distances.

Road design recommendations

RMS' rest area policy recommends rest area spacings based on whether the rest area is intended for light vehicles or trucks. Light vehicle rest areas are recommended to be spaced between 50 kilometres (for a major road) and 160 kilometres (for a minor road) apart. Major truck rest areas are recommended to be spaced between 100 kilometres (for a major road) and 160 kilometres (for a minor road) apart.

Current situation

While RMS does not provide rest areas along the corridor, there are a number of rest opportunities provided by attractions and retail outlets, including fruit stalls, Mount Tomah Botanic Garden and the Zig Zag Railway.
Figure 6.7
Location of overtaking lanes

Key
- Overtaking lane eastbound
- Overtaking lane westbound
6.3 Crash analysis

A crash analysis was undertaken, based on data for the five year period 2006–2010 for the Bells Line of Road corridor (including Chifley Road) between North Richmond and Lithgow. Key crash statistics and a section-by-section analysis are presented below. A separate technical paper, *Bells Line of Road Long Term Strategic Plan – 2006–2010 Crash Analysis* (Arup 2012), provides more detail on crash characteristics.

### 6.3.1 Key crash statistics

From 2006–2010, police reported 466 crashes. These included:

> Nine fatal crashes that resulted in 13 fatalities.
> 178 injury crashes that resulted in a further 227 injured.

The following key points were noted from the data, primarily by comparing the Bells Line of Road data with crash data for the Sydney and Western regions for the same period:

> Based on the number of crashes and the estimated AADT volumes for each section of Bells Line of Road, the crash rate is approximately 54 crashes per 100 million vehicle kilometres or approximately 1 fatal crash per 100 million vehicle kilometres. These rates are relatively high, around twice the typical rates for rural roads in NSW.
> Speeding is the highest contributing factor for crashes and is recorded as a contributing factor in a much higher percentage of crashes than either fatigue or alcohol. It is further noted that speeding was recorded as a contributing factor for a much higher proportion of crashes compared to the Sydney and Western regions for the same period.
> Crashes on curves (off-road on a curve, off-road on curve hitting an object and out of control on curve) represent a much higher proportion of crashes compared to the Sydney and Western regions.
> Head-on crashes (not involving an overtaking movement) also represent a much higher proportion of crash movements compared to the Sydney and Western regions. As would be expected, head-on crashes have the highest severity (in terms of casualties) compared to other crash types.

<table>
<thead>
<tr>
<th>Section No.</th>
<th>Section Length</th>
<th>No. Crashes in 5 years</th>
<th>No. of Fatal Crashes in 5 Years</th>
<th>2011 AADT (approx)</th>
<th>Crashes per 100MVkm</th>
<th>Fatal Crashes per 100MVkm</th>
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| Total       | 77.69          | 466                    | 9                               | 54                  | 1                    |                           |

Table 6.4 Crash statistics by section (2006–2010)

Crash data from the RMS crash database.
Figure 6.8
Location of crashes 2006-2010

Key
- Fatal Crash
- Injury Crash
- Non-Casualty Crash
> The proportion of crashes that occurred in the rain was much higher than in the Sydney and Western regions. Similarly, a significantly higher proportion of crashes occurred when the road surface was wet compared to the Sydney and Western regions.

> The proportion of accidents occurring at intersections was low compared to the Sydney and Western regions.

> Motorcycles are involved in a higher proportion of total crashes compared to the Sydney and Western regions. This may be due in part to Bells Line of Road being a popular motorcycle route.

> Compared to the Sydney and Western regions, a high proportion of crashes occurred during the weekend.

### 6.3.2 Section-by-section analysis

The 18 sections of the Bells Line of Road were evaluated in terms of key crash characteristics and a summary of the analysis is presented in Table 6.4. Locations of crashes are shown in Figure 6.8.

The table shows that some sections of the road have a very high crash rate, mainly sections 7, 10, 11, 15 and 18. Section 15 stands out as having a very poor record in terms of crashes, with 313 crashes per 100 million vehicle kilometres. Sections 5 and 6, while not having a high overall crash rate, experienced an unusually high proportion of crashes on Fridays.

Further assessment of these sections is provided below.

**Sections 5 and 6 (Kurrajong Heights to Mount Tomah Botanic Garden)**

These sections are the closest fully rural road sections to Sydney, and are within the National Park. While the geometry in these sections is reasonable and the overall crash rates are relatively low, one characteristic common to both sections is that a relatively high proportion of crashes within these sections occur on Fridays.

Further review showed that a high proportion of these Friday crashes are occurring at night and so may be due to Sydney drivers leaving for the weekend and being unfamiliar with the road at night.

**Section 7 (Berambing to Mount Tomah Botanic Garden)**

The road in this section climbs up Mount Tomah and has steep grades combined with tight geometry and narrow shoulders. Notable crash characteristics include:

> 10 out of the 18 crashes, or 56 per cent of crashes, occurred at the weekend, compared to 37 per cent for the entire Bells Line of Road, which is already high compared to the Sydney and Western regions.

> 17 to 20 year olds were controlling the vehicle in 6 of the 18 crashes in this section, or 33 per cent of crashes, compared to 17 per cent for Bells Line of Road overall.

**Section 10 (Blue Mountains National Park to Mount Wilson Road)**

The road in this section has poor horizontal geometry, narrow shoulders and some sections of steep grade with reduced shoulder widths. This section has three tight radius bends, which accounts for a cluster of crashes in the vicinity. Notable crash characteristics include:

> Speeding was a contributing factor in 18 out of the 22 crashes, or 82 per cent, compared to 56 per cent for Bells Line of Road, which is already high compared to the Sydney and Western regions. These crashes could be associated with the difficult road geometry, with drivers driving with excessive speed for the prevailing road conditions.
> 18 out of the 22 crashes, or 75 per cent, occurred on a curve, compared to 50 per cent for Bells Line of Road.

Section 11 (Mount Wilson Road to Darling Causeway at Bell)

While the road in this section has generally acceptable horizontal and vertical geometry, shoulder widths and clear zones are restricted. Notable crash characteristics include:

> Speeding was the contributing factor in 31 out of the 39 crashes, or 80 per cent, compared to 56 per cent for Bells Line of Road, which is already high compared to the Sydney and Western regions.
> 22 out of the 39 crashes, or 56 per cent, occurred when it was raining, compared to 50 per cent for Bells Line of Road.
> 20 out of the 39 crashes, or 51 per cent, of crashes involved a casualty (fatality or injury) compared to 37 per cent for Bells Line of Road.
> 15 out of the 38 crashes, or 39 per cent, occurred on a Sunday, compared to 18 per cent for Bells Line of Road.
> 14 out of the 39 crashes, or 36 per cent, occurred between 1pm and 3pm, compared to 15 per cent for Bells Line of Road.

There are also two locations points where crash clusters are located on tight horizontal and vertical curves which are combined with overtaking lanes. This combination of factors may be contributing to the number of crashes at these two locations.

Section 15 (From Zig Zag Railway to Hartley Valley Way)

The road in this section has very poor horizontal and vertical geometry, with restricted shoulder widths. The road descends about 200 metres as it approaches Lithgow. Crashes were fairly consistent along the descent, with four crash clusters at sharp bends with steep grades. Notable crash characteristics include:

> Speeding was the contributing factor in 104 out of the 114 crashes, or 91 per cent, compared to 56 per cent for Bells Line of Road, which is already high compared to the Sydney and Western regions.
> 97 out of the 114 crashes, or 85 per cent, occurred on a curve, compared to 50 per cent for Bells Line of Road.
> 96 out of the 114 crashes, or 84 per cent, involved a single vehicle, compared to 58 per cent for Bells Line of Road.
> 79 out of the 114 crashes or 69 per cent occurred when it was raining, compared to 38 per cent for Bells Line of Road. Although the crash rate in this section is very high, the crash severity (crash involving a fatality or injury) is low, with no fatalities. Seventeen out of the 114 crashes, or 15 per cent, involved a casualty (fatality or injury), compared to 39 per cent for Bells Line of Road.

Section 18 (Main Street to Great Western Highway)

This section passes adjacent to the retail and commercial centre of Lithgow and extends through to the Great Western Highway, all in a 50 kilometre per hour zone. The horizontal and vertical geometry is good. A comparison of crash data for this section with Bells Line of Road as a whole shows that:

> 43 out of 49 crashes, or 86 per cent, involve multiple vehicles, compared to 42 per cent for Bells Line of Road overall.
> 31 out of 49 crashes, or 43 per cent, are located at intersections, compared to 17 per cent for Bells Line of Road.
> 18 out of 38 crashes, or 47 per cent, are rear-end crashes, compared to 12 per cent for Bells Line of Road.
> 16 out of 49 crashes, or 33 per cent, occurred on a Thursday, compared to 11 per cent for Bells Line of Road.
> 13 out of 49 crashes, or 27 per cent, occurred in the McLean Period G (Thursday to Friday 3pm to 9pm), compared to 11 per cent for Bells Line of Road.
> 10 out of 49 crashes, or 20 per cent, involve either pedestrian or cyclist, compared to 4 per cent for Bells Line of Road.
These high percentages of crash types compared to Bells Line of Road as a whole reflect the higher levels of congestion in this section, with many intersections, large number of turning movements and the stop-start nature of the traffic. Late night shopping on Thursdays may also be contributing to the higher crash rates during this time period.

6.4 Engineering analysis – overview

The key points from the engineering analysis are that:

> The Bells Line of Road from North Richmond to Lithgow features a wide variety of road characteristics and changing speed limits.

> There are many locations where the existing horizontal and vertical road geometry falls below current new road standards and guidelines. In particular this includes tight horizontal curves, steep grades, and sharp crest curves affecting sight distance.

> Overtaking opportunities are restricted by the horizontal and vertical geometry and there are few overtaking lanes. In particular, there is a 25-kilometre-long section between Kurrajong Heights and Mount Tomah where there is no overtaking lane in either direction.

> For most of the corridor the road cross-section is also below current new road standards and guidelines. This includes lane widths, sealed shoulder widths and clear zone widths.

As a consequence of the above, the Bells Line of Road has a poor crash record. At about 54 crashes per 100 million vehicle kilometres travelled, or 21 casualty crashes per 100 million vehicle kilometres travelled the crash rates are considerably higher than the typical rates for rural roads in NSW. Particular features of the high crash rates are:

> Speeding is the highest contributing factor for crashes and is recorded as a contributing factor for a much higher proportion of crashes than in the overall Sydney Region or Western region.

> Crashes on curves represent a much higher proportion of crashes compared to the Sydney and Western regions.

> Head-on crashes (not involving an overtaking movement) also represent a much higher proportion of crash movements compared to Sydney and Western regions.

> Motorcycles are involved in a higher proportion of total crashes compared to the Sydney and Western regions.

> Compared to the Sydney and Western regions, a high percentage of crashes occurred during the weekend.

While Bells Line of Road as a whole has a poor crash record and certain crash types and characteristics are over-represented, there are some sections of the Bells Line of Road where there appear to be particular problems contributing to even higher crash rates. These are summarised below:

> Section 7 (Berambing to Mount Tomah Botanic Garden), which has poor geometry and a high crash rate. A high proportion of crashes occurred at the weekend, and a high proportion of crashes involved 17 to 20 year old drivers.

> Section 10 (Blue Mountains National Park to Mount Wilson Road), which has poor geometry and a high crash rate. Speeding was a high contributing factor and 75 per cent of crashes occurred on a curve.

> Section 11 (Mount Wilson Road to Darling Causeway at Bell), which has average geometry but a poor crash record. Speeding was a major contributing factor and many crashes occurred when it was raining. A high proportion of crashes
involved a casualty (fatality or injury) and a high proportion occurred on Sundays. There are also two locations in this section where crash clusters are located on tight horizontal and vertical curves which are combined with overtaking lanes.

Section 15 (From Zig Zag Railway to Hartley Valley Way) has poor horizontal and vertical geometry, with restricted shoulder widths. Crash rates are extremely high, with four crash clusters at sharp bends with steep grades. Speeding was a contributing factor in 91 per cent of the 114 crashes, and 85 per cent of crashes occurred on a curve. Most were single vehicle crashes and most were when it was raining. However the crash severity (proportion of crashes involving a fatality or injury) is low, with no fatalities.
Part C – Outcomes of the Plan
7 Broad options, needs and opportunities

The preceding chapters provide information on what is known about the Bells Line of Road corridor from investigations into aspects such as transport, engineering and environmental and social issues, as well as the issues identified during the public consultation process. They set out the needs and constraints that are key inputs into planning for the corridor.

This chapter presents a range of improvement options and opportunities that could address these deficiencies. These provide a platform for nominating development and improvement priorities, which are presented in Chapter 8.

7.1 Broad options

There are two broad improvement options available to meet the corridor objectives described in Chapter 2. These can be summarised as follows:

> A major upgrade in the longer term, with associated connections to the broader road network and corridor reservation in the interim.

> Short and medium term improvements focused on the existing corridor.

The above options are not mutually exclusive and a combination could be implemented at different stages and at different locations in the corridor. The opportunities around these broad options are discussed in the sections below.

7.2 Strategic opportunities for a major upgrade of the Bells Line of Road corridor

A major future upgraded Bells Line of Road would generally be expected to be two-lanes in each direction with appropriate overtaking lanes, and constructed to a high speed standard. It may include an entirely new route, or a realignment or widening of a significant section of Bells Line of Road.

The transport analysis undertaken as part of this project indicates that there is anticipated to be a traffic efficiency justification for a major upgrade of Bells Line of Road east of Kurrajong Heights in the long term. However, projected traffic volumes even under a high growth scenario suggest that a major upgrade west of Kurrajong Heights is not justified in the foreseeable future.

In terms of a future upgrade east of Kurrajong Heights, traffic analysis shows that a substantial proportion of traffic originating from within and beyond the corridor is bound for the Sydney metropolitan area. Therefore, the Bells Line of Road requires an effective ongoing connection to the Sydney motorway network. Existing congestion at North Richmond currently affects this connection at peak times, while traffic forecasts suggest that congestion may occur as far west as Kurrajong Heights in the long term if no network improvements are undertaken. Likewise, significant development pressures in north-western Sydney mean that reservation of a corridor is required in the short to medium term, with the process to reserve a corridor commencing in the short term.
7.2.1 Opportunities for an eastern corridor upgrade

The following strategic opportunities have been identified for an upgraded Bells Line of Road east of Kurrajong Heights:

> Upgrade primarily within the existing alignment, including upgrading of Richmond Bridge and its approaches, and connecting with the Blacktown Road/Richmond Road corridor, which would also be upgraded as appropriate.

> Establish a new connection between Kurrajong Heights and the Sydney motorway network, which may utilise sections of the existing road network such as The Driftway, Richmond Road and/or Londonderry Road, or rely on an entirely new corridor.

> Establish a new connection that crosses the Hawkesbury (or Nepean) River further south and utilises all or part of the Castlereagh Freeway corridor to connect with the M7 Motorway at Dean Park.

Under current RMS planning, Richmond Road is proposed to be progressively upgraded to a six-lane urban arterial road as the North West Growth Centre develops. However, it is unlikely that an upgrade primarily within the existing alignment will provide an efficient long term connection between the Bells Line of Road and the Sydney motorway network, as it traverses existing and future urban areas and will continue to provide access for local traffic. Nonetheless, a future upgrade of Richmond Road may provide opportunities for short to medium term improvements to traffic congestion in the eastern corridor.

A new corridor, or a corridor that utilises parts of the existing network, is more likely to provide an efficient long term connection between Kurrajong Heights and the Sydney motorway network.

It is unlikely that traffic associated with the Bells Line of Road would in itself justify development of the Castlereagh Freeway corridor. If the Castlereagh Freeway corridor is developed for other reasons, such as large urban releases between the North West Growth Centre and Penrith or as an alternative access route to Penrith, then a connection between the Bells Line of Road at Kurrajong and the Castlereagh Freeway corridor would potentially be viable in the long term.

Any option to connect Kurrajong Heights to the Sydney motorway network would require extensive and rigorous investigations to identify a cost-effective route that efficiently negotiates the change in elevation while minimising socio-economic and environmental impacts.

7.2.2 Opportunities for improved connections to the Great Western Highway (in the Lithgow area)

The following strategic opportunities have been identified for improved connections between the Bells Line of Road corridor and the Great Western Highway in the Lithgow area:

> Use the existing road corridor through Lithgow, with traffic rationalisation where appropriate.

> Use the Darling Causeway to connect with the Great Western Highway at Mount Victoria, with upgrades to Darling Causeway and the Great Western Highway as appropriate.

Other opportunities have been considered in previous studies, including a route across the Newnes Plateau to the north of Lithgow and routes through the Hartley Valley. These previous studies have found these routes to have limited feasibility. The analyses conducted as part of the preparation of this Plan reaffirms these outcomes, particularly in terms of environmental constraints, and they are not regarded as strategic opportunities for the purposes of corridor planning.
7.3 Short and medium term improvements to the existing corridor

7.3.1 Minor curve realignments and straightening

The need
The engineering analysis identified a number of sections of Bells Line of Road that have tight curves which could be improved by minor realignment and straightening to improve road safety and capacity. The results of the engineering analysis are reinforced by the crash analysis (refer to Chapter 6), which identified higher crash rates within these areas compared to other sections of the Bells Line of Road.

Opportunities
There is an opportunity to undertake a program of horizontal and vertical curve straightening at key locations, and particularly where tight curves are combined with steep grades. This includes:

> For various curves in the 6 kilometre section between Kurrajong and Kurrajong Heights (including Bellbird Hill), which has a design speed of 60 kilometres per hour or less.
> In the vicinity of Mount Tomah, which has a design speed of 70 kilometres or less.
> For various curves in the eight kilometre section between Newnes Junction and Lithgow, which has a design speed of 60 kilometres per hour or less.

This type of improvement would generally provide a good standard rural road with a target design speed of 70 to 80 kilometres per hour. Generally, one lane in each direction would be adequate, with climbing lanes provided on long, steep uphill grades.

Opportunities for minor realignments and straightening are likely to be affected in some locations by the environmental, social and technical constraints discussed in Chapter 5. Sensitive design and detailed environmental impact assessment is likely to be required in areas where this treatment is potentially appropriate.

7.3.2 Overtaking

The need
Road sections that have long distances without an overtaking lane can result in increased risk-taking by motorists.

Most of Bells Line of Road has only one lane in each direction and overtaking opportunities are restricted by the numerous curves in the road. Crash statistics suggest that the existing overtaking lanes may be too short in some locations and that the lack of overtaking opportunities may have contributed to motorists taking greater risks on occasions.

Opportunities
The engineering analysis identified that the following locations have sections of 10 kilometres or more with no overtaking opportunities, or would otherwise benefit from additional overtaking opportunities:

> In both directions in the section between Kurrajong Heights and Mount Tomah.
> For westbound traffic west of Bell.
> For eastbound traffic between Dargan and Mount Wilson.
> At Mount Tomah, where the long, steep grades cause truck speeds to drop to around 40 kilometres per hour. The only additional lane in this location is a climbing lane for eastbound traffic.
The feasibility of providing overtaking opportunities in these locations would partly depend on a detailed examination of environmental and engineering constraints.

7.3.3 Lanes, shoulders, clear zones, safety barriers and improved drainage

The need
The engineering analysis identified the following needs:

> Wider lanes – the assessment suggests that lanes are narrower than RMS’ recommended width of 3.5 metres for roads carrying more than 2000 vehicles per day. Lanes are typically 3–3.2 metres wide. Narrow lanes reduce the lateral clearance between vehicles, reducing safety, travel speeds and road capacity.

> Shoulders – RMS recommends a sealed shoulder width of at least 1 metre for roads carrying more than 2000 vehicles per day. The engineering analysis identified that sealed shoulders are narrower than this for most of Bells Line of Road. Narrow shoulders reduce the opportunity for an errant vehicle to recover and return safely to the roadway, reduce the available safety margin for avoiding vehicles travelling in the opposite direction, and limit the opportunity for a vehicle to safely stop clear of the running lane.

> Clear zones – for the traffic volumes on Bells Line of Road and with a flat verge RMS recommends clear zones between three metres at 60 kilometres per hour to nine metres at 100 kilometres per hour. However, the engineering analysis identified that the available clear zone widths in each direction are generally significantly less than these targets for the design speed. Trees are the most common hazards in the clear zones. The analysis showed that clear zones are more limited east of Bilpin, where traffic volumes are higher.

> Drainage – the crash analysis identified a relatively high proportion of accidents on Bells Line of Road occurring in wet weather. While this does not necessarily indicate that there are drainage issues, this statistic and community feedback on road drainage issues suggests that road drainage characteristics should be examined in detail to determine if drainage improvements could improve road safety.

Opportunities
A program of lane and shoulder widening from the Bilpin Fruit Bowl to 10 kilometres west of this point is currently in the planning phase and is proposed to be implemented by RMS in 2012. There is an opportunity to ultimately extend this to other locations in the Bells Line of Road corridor.

At any locations where an adequate clear zone cannot be achieved, consideration may be given to installing a section of safety barrier.

There is also an opportunity to implement minor drainage improvements as part of these works to address any areas where inadequate drainage allows runoff to cross the road during periods of heavy rainfall.

Higher priority should be given to lengths within these sections where tight curves are combined with steep grades.

7.3.4 Pedestrian and cycle access

The need
The narrow shoulders that occur in much of the corridor mean that cyclists are obliged to be on or very close to the traffic lanes, increasing their risk of accidents.

There are some locations (primarily the villages along the route) where higher pedestrian and cyclist activity occurs, and safety and efficiency could potentially be improved.
Opportunities
Providing better cycle access mostly involves improved shoulder treatments, as addressed in Section 7.3.3.

There may also be opportunities to improve or create dedicated off-road pedestrian and cycle links within villages.

### 7.3.5 Intersections

**The need**
Intersections are a potential road safety issue, particularly when there are no turning lanes or there is limited sight distance. The Bells Line of Road/Kurmond Road and Bells Line of Road/Comleroy Road intersections have a relatively high number of crashes, suggesting a need for improvement.

**Opportunities**
There is an opportunity to make improvements to intersections that have safety issues, geometric constraints or higher turning volumes. The improvements could focus on providing turning lanes, widening shoulders, and improving sight lines.

### 7.3.6 Driveways

**The need**
Observations and community comments indicate that many driveways directly connecting to Bells Line of Road have restricted sight distance in one or both directions.

**Opportunities**
There are opportunities to identify driveways where sight distance or other aspects are hazardous. It may be possible to rationalise these driveways by constructing short lengths of access roads. This would require extensive consultation and negotiation with the land owners concerned and it would directly affect property access.

### 7.3.7 Slopes

**The need**
The steep embankments in parts of the corridor are prone to land slip, which could result in debris on the road or shoulder. This in turn can create a hazard for motorists.

**Opportunities**
RMS has an ongoing program of slope evaluation and stabilisation. Works are carried out in the corridor under this program. Any lane and shoulder widening would create the opportunity to treat and protect slopes in such a way that ongoing maintenance and future risks of land slips are substantially reduced in those areas.

### 7.3.8 Bridge safety

**The need**
Apart from the Hawkesbury River Bridge at Richmond, there are only two bridges crossing creeks and two railway overpasses between North Richmond and Lithgow. These are:

- Redbank Creek Bridge – this is located on the outer edges of North Richmond. It is narrow (about 6.5 metres between barriers). The bridge is speed limited to 60 kilometres per hour.
- Little Wheeny Creek Bridge – this is located in the Kurrajong section. It is relatively narrow at 5.5 metres between white lines, and has a speed limit of 80 kilometres per hour.
- Bell railway overpass – this has acceptable width.
> Newnes Plateau overpass – this is narrow (approximately 5.75 metres between white lines), barely allowing two trucks to pass.

**Opportunities**

There is the opportunity to improve the bridges listed above as follows:

> Redbank Creek Bridge could be widened to approximately 9.0 metres between barriers.
> Little Wheeny Creek Bridge could be widened to approximately 9.0 metres between barriers and the barriers could be upgraded to current standards.
> The railway overpass just west of Newnes Junction Plateau overpass could be widened to 9.0 metres between barriers and the barriers could be upgraded to current standards. This may involve considerable cost.

### 7.3.9 Rest areas

**The need**

Rest opportunities are important in the context of the distances being driven by some users of the corridor. While there are no formal rest areas in the corridor, there are a number of rest opportunities (such as fruit stalls, council facilities at Mount Tomah near Charleys Road, Mount Tomah Botanic Gardens, and the Prisoner of War Memorial near Clarence).

There are fewer rest opportunities in the national park areas west of Bilpin. While there are several entry roads into the national parks, they do not lead to any rest opportunities (such as lookouts) that are both accessible and of high quality.

**Opportunities**

There are opportunities to provide additional rest opportunities within the national park areas by upgrading existing or establishing new picnic or lookout areas. This would require collaboration between RMS and the National Parks and Wildlife Service.

In addition, safer, more efficient access could be made available to some roadside rest opportunities.

### 7.3.10 Urban and landscape design

**The need**

While the Bells Line of Road corridor passes through some highly scenic and distinctive landscapes, there is no framework for managing this from an overall character perspective, other than RMS’ statewide urban design framework, *Beyond the Pavement*, available on the RMS website.

**Opportunities**

There is an opportunity to improve the cultural and natural landscapes of the corridor through the development of a corridor urban design framework, which could provide a clearer vision of the character of the road.

An urban design framework would be associated with a program of road improvements. It would enable appropriate landscape and urban design treatments to be incorporated into these improvements.

### 7.3.11 Environmental improvements

**The need**

The Bells Line of Road corridor passes through highly sensitive natural environments, including parts of the Greater Blue Mountains World Heritage Area. There are also ecologically
sensitive areas of vegetation within the road reserve that are likely to include Endangered Ecological Communities.

The construction and operation of the road needs to address the sensitivity of these adjacent environments in terms of weed management, water quality management and wildlife movement.

**Opportunities**

There is the opportunity to implement a coordinated environmental management framework throughout the corridor that addresses weed, water quality and wildlife issues.

In addition, there may be an opportunity for existing ecologically degraded areas to be improved either as part of road improvement works or general road maintenance activities.

A focus on maintaining native regeneration processes within the road reserve is likely to lead to lower long term maintenance costs (for example through reduced need for weed removal) and improved ecological outcomes.
8 Corridor development priorities

This chapter presents the development priorities for the Bells Line of Road transport corridor. It builds on the outcomes of the previous chapters to provide a concise set of outcomes that will enable a corridor reservation east of Kurrajong Heights as well as improvements to the existing corridor.

The Long Term Strategic Corridor Plan for the Bells Line of Road corridor is presented in the schedules below. The Plan will guide the reservation of a road corridor for a future upgraded Bells Line of Road east of Kurrajong Heights.

A corridor reservation west of Kurrajong Heights is not a priority, taking into account current land use, transport and policy considerations.

The Plan also provides priorities for undertaking other improvements to the existing corridor. Development priorities are categorised as:

> Short term (0–5 years).
> Medium term (5–20 years).
> Long term (20+ years) priorities.

Some development priorities will take place over long periods of time, and so will occur over more than one time frame category.

The schedules also show the relationship between the development priority and corridor objectives as described in Chapter 2. Many proposed improvements relate to more than one objective. The tables indicate the primary objective being addressed as well as secondary objectives, where appropriate.

The process for the implementation of development priorities is described in Chapter 9.
# Short term corridor development priorities (0–5 years)

## Corridor reservation and network connections

| S1 | Develop options, select preferred option and commence the process of reservation of a corridor between Kurrajong Heights and the Sydney motorway network. Corridor location to consider opportunities identified in Chapter 7 of this Plan. | ■ | ■ | ■ | Eastern corridor options study |
| S2 | Continue planning and development of Blacktown Road/Richmond Road ensuring that it addresses future traffic loads from Bells Line of Road. | ■ | ■ | ■ |
| S3 | Continue planning and development to address traffic congestion at North Richmond in accordance with the short term outcomes of the Richmond Bridge and approaches congestion study. | ■ | ■ | ■ | Richmond Bridge and approaches congestion study |

## Improvements to the existing corridor

| S4 | Investigate overtaking opportunities between Kurrajong Heights and Mount Tomah. | ■ | ■ | ■ | Overtaking lanes review |
| S5 | Investigate opportunities to improve existing overtaking lanes in accordance with outcomes of the overtaking lane review. | ■ | ■ | ■ | Overtaking lanes review |
| S6 | Continue the current program of shoulder widening, lane widening and clear zone improvements between Bilpin and Berambing. Implement drainage improvements where required as part of these works. | ■ | ■ | ■ | Current maintenance strategy |
| S7 | Investigate opportunities to improve intersections including improving sight distance and providing turning lanes as appropriate. | ■ | ■ | ■ | Intersection review |
| S8 | Investigate opportunities to provide general safety improvements. | ■ | ■ | ■ | Safety review |
| S9 | Continue the current program of improving slope stability at higher risk locations in the corridor. | ■ | ■ | ■ | Current maintenance strategy |
| S10 | Continue to implement pavement improvements in accordance with current maintenance procedures. | ■ | ■ | ■ | Current maintenance strategy |
### Medium term corridor development priorities (5–20 years)

#### Corridor reservation and network connections

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<td>Undertake a program of horizontal and vertical curve straightening for key sub-standard curves (identifying synergies with shoulder and lane widening program).</td>
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<td>M7</td>
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<td>Overtaking lanes review</td>
</tr>
<tr>
<td>Continue to implement program of additional overtaking opportunities as identified.</td>
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<td>M8</td>
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<tr>
<td>Continue to implement improvements to existing overtaking lanes in accordance with outcomes of overtaking lane review.</td>
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</table>

*Continued on following page*
### Medium term corridor development priorities (5–20 years)

*continued from previous page*

<table>
<thead>
<tr>
<th>Corridor objective</th>
<th>Safety</th>
<th>Transport and access</th>
<th>Land use and development</th>
<th>Environment</th>
<th>Planning and implementation reference (see Chapter 9 for details)</th>
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<tr>
<td>M9</td>
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<td>Intersections review</td>
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<tr>
<td>Continue to implement intersection improvements in accordance with outcomes of the intersection review.</td>
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<td>M10</td>
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<td>Access review</td>
</tr>
<tr>
<td>Continue to implement program of rationalising driveway access in accordance with the access review.</td>
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<td>M11</td>
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<td></td>
<td>Safety review</td>
</tr>
<tr>
<td>Implement program of bridge improvement to maintain lane and shoulder widths consistent with adjacent road.</td>
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<td>M12</td>
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<td>Slope maintenance</td>
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<tr>
<td>Continue the current program of improving slope stability at higher risk locations in the corridor.</td>
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**Key**
- ■ Primary related objective
- □ Secondary related objective(s)
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<th>Corridor objective</th>
<th>Safety</th>
<th>Transport and access</th>
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<tr>
<td><strong>Long term corridor development priorities (beyond 20 years)</strong></td>
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<td><strong>Corridor reservation and network connections</strong></td>
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<tr>
<td>L1</td>
<td>Construct an upgraded (four-lane) link between Kurrajong Heights and the Sydney motorway network.</td>
<td>☐</td>
<td>■</td>
<td>Eastern corridor options study</td>
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<tr>
<td>L2</td>
<td>Continue to address traffic congestion at North Richmond in accordance with any long term recommendations from the Richmond Bridge and approaches congestion study.</td>
<td>☐</td>
<td>■</td>
<td>Richmond Bridge and approaches congestion study</td>
<td></td>
</tr>
<tr>
<td>L3</td>
<td>Continue to undertake improvements to the Blacktown Road/Richmond Road corridor as required.</td>
<td>■</td>
<td>☐</td>
<td>Relevant western Sydney RMS planning strategy</td>
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</tr>
<tr>
<td>L4</td>
<td>Continue to improve intersections through Lithgow to maximise transport efficiency.</td>
<td>☐</td>
<td>■</td>
<td>Access review</td>
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</table>
9 Implementation framework

This chapter outlines the next steps to be taken in the planning process for the reservation of a road corridor for a future upgraded Bells Line of Road as well other measures for the short, medium and long term future. It provides a schedule of tasks for the selection of a preferred corridor and a summary of additional work required.

9.1 Overview of the framework

Chapter 8 provides a list of development priorities for the reservation of a road corridor for a future upgraded Bells Line of Road as well other priorities for the short, medium and long term future.

The next steps to achieving this will be guided by an implementation framework that integrates the different levels of planning and design. This framework is shown in Figure 9.1. The key elements are:

- **Corridor reservation process** – the commencement of the identification and reservation of an upgraded road corridor between Kurrajong Heights and the Sydney motorway network is identified as a short term priority in Chapter 8. The activities to identify the location of the corridor and reserve it are outlined in Section 9.2.

- **Existing corridor improvement process** – the need for short, medium and long term improvements to the existing Bells Line of Road corridor between North Richmond and Lithgow is another important aspect of this Plan. The tasks required for these improvements are outlined in Section 9.3.

The framework is described in more detail below.

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**Figure 9.1 Planning and implementation framework**
9.2 Next steps – corridor reservation process

The need for the reservation of an upgraded road corridor connecting Kurrajong Heights with the Sydney motorway network is established in this Plan. The commencement of planning for the identification of a preferred route and reservation on councils’ Local Environmental Plans is identified as a short term priority (0–5 years), and could be expected to continue into the medium term (5–20 years). The construction of an upgraded corridor is expected to be required in the long term (20+ years). Given changing land use in western Sydney and the need to provide certainty for land owners and land use planners, the corridor needs to be identified and reserved well in advance of major construction.

The Plan also identifies that the reservation of an upgraded corridor west of Kurrajong Heights is not a priority, taking into account current land use, transport and policy considerations. The additional work required to reserve an upgraded road corridor and the timeframes for each planning phase are shown in Figure 9.2 and described below. It should be noted that the commencement of each phase will be subject to availability of funding and there may be gaps between each phase being undertaken.

Route options study
Timeframe: 2–4 years from engagement of contractor

The purpose of the route options study is to identify and develop feasible route options and, taking into account technical studies and community input, recommend a preferred route for an upgraded road corridor. While Kurrajong Heights and the Sydney Motorway Network have been identified as nominal extents for corridor connections, the specific connection locations would be developed and there would be some flexibility regarding the eastern and western extents of the study area.

Preferred route announcement
Timeframe: Following conclusion of route options study

The decision on a preferred route is made by the NSW Minister for Roads and Ports, taking into account the recommendations of the route options study. The Minister’s decision on a preferred route would be announced to the community, and all potentially affected landholders contacted.

Concept design
Timeframe: 1–1.5 years

Following the announcement of a preferred route, concept design for the route is undertaken in order to set property boundaries for inclusion in councils’ Local Environmental Plans as a reserved corridor. This process would involve targeted analyses of socio-economic, environmental, cultural, and engineering considerations. It would also involve detailed discussion with affected landholders, agencies and other stakeholders.

Corridor reservation
Timeframe: In excess of six months depending on status of councils’ Local Environmental Plans

The reservation of a future upgraded road corridor can take place once the concept design has been prepared and future property boundaries established. To undertake this process, RMS would write to councils, requesting that the road corridor be included in their Local Environment Plans. Councils would then need to amend existing Local Environmental Plans or include the
corridor in new Local Environmental Plans. These would undergo statutory consultation before being approved by the Minister for Planning and Infrastructure and formally gazetted. Once fully incorporated into Local Environmental Plans, the corridor would be regarded as being reserved.

9.3 Next steps – existing corridor improvement process

In addition to the need to reserve an upgraded road corridor between Kurrajong Heights and the Sydney motorway network, a range of other short, medium and long term improvements have been identified as being required to address the ongoing function and needs of the corridor. The priorities for these improvements are outlined in Chapter 8 of this document.

The additional work required to provide these improvements comprises a series of technical investigations to identify a schedule of improvements that address the needs of the corridor and best represent value for money.

These investigations are described individually below, but may be undertaken concurrently and in an integrated fashion. It should be noted that the commencement of these investigations will be subject to the availability of funding.

9.3.1 Safety review

Timeframe: 6–12 months

The development priorities identified in Chapter 8 include the need for a safety review. The safety review is required to:

> Identify safety issues within the corridor.
> Evaluate potential measures to address the safety issues in terms of effectiveness, cost and environmental impact.
> Identify preferred safety measures in order of priority at a level of detail that will allow incorporation of measures into RMS budget and planning processes.

9.3.2 Overtaking lane review

Timeframe: 6–12 months

The development priorities identified in Chapter 8 include the need for an overtaking lane review. This review is required in order to:

> Provide a detailed assessment of the adequacy of existing overtaking lanes, including length, geometry, line marking and signage.
> Identify specific locations (including lengths) for additional overtaking lanes at a level of detail that will allow incorporation into RMS budget and planning processes. This includes the identification of the overtaking lanes between Kurrajong and Mount Tomah that are a short term development priority.
> Identify improvements required to existing overtaking lanes.
> Identify priorities for the implementation of new and improved overtaking lanes.

9.3.3 Intersections review

Timeframe: 6–12 months

The development priorities identified in Chapter 8 include the need for an intersection performance review. This review is required to:

> Provide a detailed evaluation of intersections within the corridor in terms of safety and transport efficiency.
> Identify the types of improvements that may be implemented to improve intersection performance and safety (including improved sight lines, additional turning lanes and staged crossings).
> Identify improvements at a level of detail that will allow incorporation into RMS budget and planning processes.
> Identify priorities for the implementation of intersection improvements.

9.3.4 Access review

**Timeframe: 6–12 months**

The development priorities identified in Chapter 8 include the need for a review of local access arrangements. This review is required to:

> Provide a detailed assessment of access characteristics within the corridor, identifying particular safety and transport efficiency issues.
> Identify opportunities to address safety related access issues within the corridor.
> Outline a program to improve access arrangements at a level of detail that will allow incorporation into RMS budget and planning processes.
> Identify priorities for the implementation of access improvements.

9.3.5 Richmond Bridge and approaches congestion study

The Richmond Bridge and approaches congestion study is investigating options that would assist in alleviating traffic congestion at North Richmond. The study is being carried out in two stages:

The Stage 1 study includes:
> Analysing the current traffic situation in order to identify potential short and medium term solutions.

> Investigating the structural suitability of the existing bridge for upgrade or widening.

The Stage 2 study includes:
> Developing of strategic concept design options for Richmond Bridge and approach roads between Richmond and North Richmond for a longer term solution.

9.4 Future reviews of the Long Term Strategic Corridor Plan

This Plan may be reviewed and updated in response to changing transport network characteristics, government policy and/or community values. It may also require updating as development priorities listed in Chapter 8 are implemented and new priorities are identified.

Any review of the Plan would require appropriate consultation with the community, as well as updating of technical inputs to the Plan.
Appendix A

Terms of Reference
for the Bells Line of Road Long Term Strategic Corridor Plan
BELLS LINE OF ROAD CORRIDOR
LONG TERM STRATEGIC CORRIDOR PLAN

Terms of Reference

Purpose:
The NSW Roads and Traffic Authority (RTA), on behalf of the NSW and Australian Governments, is to prepare a Long Term Strategic Corridor Plan for the Bells Line of Road corridor. The Long Term Strategic Corridor Plan will guide the development and reservation of a road corridor for a future upgraded Bells Line of Road. Although current projections indicate that a major upgrade of Bells Line of Road is not expected to be required until at least 2033, it is appropriate that planning for this corridor progresses now for the future.

Background:
Due to urban expansion and land use changes in north-western Sydney there is a long term strategic requirement to reserve a future road corridor between Bells Line of Road and the Sydney Motorway Network.

Two recent studies that consider the need for an upgrade of Bells Line of Road are:
- Central West Transport Needs Study, SKM 2009
- Bells Line of Road Corridor Study, SKM 2004

While the findings from these studies have concluded that a substantial upgrade of Bells Line of Road is not warranted in the short to medium term on economic, social and environmental grounds; the studies have confirmed that long term strategic planning is required for the Bells Line of Road corridor, in particular considering land use pressures from urban expansion in north-western Sydney.

Approach:
The Bells Line of Road Long Term Strategic Corridor Plan will be developed through extensive consultation with local communities and stakeholders about the future of the Bells Line of Road corridor. A community involvement plan will be formulated for implementation as the study progresses.

The Bells Line of Road Long Term Strategic Corridor Plan will cover three sections:
- Eastern Section – from Bells Line of Road near Kurrajong Heights to the Sydney Motorway Network.
- Central Section – from Kurrajong Heights to Bell.
- Western Section – from Bell to the Great Western Highway.

Roles and Responsibilities:
Refer to the governance structure in Schedule 1.

Tasks:
The following will be carried out as part of developing the Long Term Strategic Corridor Plan:
a) Identify the short, medium and long term functional needs and objectives for the Bells Line of Road corridor taking into account expected future transport requirements and land use.
b) Through community consultation and strategic investigations, identify constraints, values and opportunities along the Bells Line of Road corridor.
c) Identify strategic corridor opportunities and provide commentary on potential options for the future upgrade of the Bells Line of Road corridor.
d) Provide recommendations on the process to identify and select preferred corridors and the undertaking of interim tasks.

Outputs:
Outputs of the investigations will consist of a community involvement plan and a Long Term Strategic Corridor Plan.

The Long Term Strategic Corridor Plan will include:
- Outline of the study methodology.
- Summary of findings from relevant past studies pertaining to the Bells Line of Road corridor.
- Forecast traffic growth along the route (25 year horizon).
- Identified priorities for the development of the Bells Line of Road corridor.
- Identification of broad options that meet long term corridor requirements, project objectives and project design standards.
- Summary of additional work required.
- Schedule of tasks for selection of a preferred corridor.
- Recommended timeframe for further development.
- Recommended sequencing of implementation.

Timeframe:
Completion of a final-draft Long Term Strategic Corridor Plan for Steering Committee consideration is required within 18 months of commissioning a contractor to assist in the study.
Schedule 1. Governance structure

- **NSW Minister for Transport and Roads**
- **Federal Minister for Infrastructure, Transport, Regional Development and Local Government**

**GOVERNMENTAL STEERING COMMITTEE**
- DITRDLG, RTA, NSW Transport and Infrastructure
- Department of Premier and Cabinet, Department of Planning, CENTROC, WSROC

**REFERENCE GROUP**
- RTA

**PROJECT MANAGER, PROJECT TEAM**
- RTA, DITRDLG, contractor

**LOCAL INPUT**
- Community, stakeholders, councils
<table>
<thead>
<tr>
<th>Role</th>
<th>Members</th>
<th>Responsibility/ input</th>
</tr>
</thead>
</table>
| Governmental Steering Committee  | • Department of Infrastructure, Transport, Regional Development and Local Government (DITRDLG)  
• Roads and Traffic Authority  
• NSW Transport and Infrastructure  
• NSW Department of Premier and Cabinet  
• NSW Department of Planning  
• Central NSW Councils (CENTROC)  
• Western Sydney Regional Organisation of Councils (WSROC) | Review progress in accordance with Terms of Reference and provide guidance as required. Ensure Ministers and Councils are kept informed. |
| Reference Group                  | • RTA                                                                    | Provide direction, resources and Departmental approval.                                                                                                 |
| Project Manager, Project Team    | • Roads and Traffic Authority  
• Department of Infrastructure, Transport, Regional Development and Local Government  
• Professional Services Contractor | Project management, liaise with stakeholders, and undertake project studies. Provide secretariat to Governmental Steering Committee. Manage contractors. Oversee community consultation. |
| Local input                      | • Community, stakeholders, councils                                      | The Bells Line of Road *Long Term Strategic Corridor Plan* will be developed through extensive consultation with local communities and stakeholders about the future of the road. |