



Transport  
Roads & Maritime  
Services

# **MOUNT VICTORIA TO LITHGOW GREAT WESTERN HIGHWAY – FORTY BENDS UPGRADE**

Addendum Review of Environmental  
Factors – Whites Creek Crossing

OCTOBER 2014

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## Roads and Maritime Services

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# Mount Victoria to Lithgow Great Western Highway – Forty Bends upgrade

Addendum Review of Environmental Factors – Whites Creek Crossing

October 2014

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# Executive summary

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## Background

Roads and Maritime Services proposes to upgrade the Great Western Highway at Forty Bends, about 5.5 kilometres south of Lithgow. The Forty Bends upgrade proposal (the determined proposal) includes the realignment of about 2.4 kilometres of the Great Western Highway. The proposed upgrade includes construction of new twin five span bridges across Whites Creek.

The Great Western Highway is the main road link between Sydney and Lithgow and beyond to the Central West of New South Wales. The Forty Bends upgrade will improve the road safety and traffic and freight efficiency along this section of road and is consistent with other road improvement activities along the Great Western Highway.

A Review of Environmental Factors (REF) was prepared by the Mount Victoria to Lithgow Alliance on behalf of Roads and Maritime in October 2012. After consideration of submissions from the community, Roads and Maritime recommended the progression to detailed design and construction.

After recommendation of the project, an alternative to the bridge design was investigated for the crossing of Whites Creek (hereby referred to as the revised proposal). This REF addendum only describes the changes and assesses the potential environmental impacts that are proposed to be modified since the original REF. This addendum should be read in conjunction with the original REF.

## The proposal

The revised proposal for Whites Creek crossing is no longer a bridge, but consists of a large concrete arch, earth embankment and retaining wall. The revised proposal uses the same level and alignment as the design of the original bridge.

## Need for the proposal

The Forty Bends upgrade has been designed in accordance with the Austroads Design Guides and Roads and Maritime Supplements for a design speed of 100 kilometres per hour.

The revised proposal for the Whites Creek crossing reduces the risk of black ice due to the earth embankment. The revised proposal also allows potential cost savings due to a reduction in construction and maintenance costs, while providing similar environmental outcomes.

## Statutory and planning framework

All relevant statutory planning instruments have been examined for the revised proposal. The revised proposal is permissible under Part 5 of the *Environmental Planning and Assessment Act 1979*.

Development consent under Part 4 of the *Environmental Planning and Assessment Act 1979* is not required. Clause 94 of the State Environmental Planning Policy (Infrastructure) 2007 permits development on any land for the purpose of a road or

road infrastructure facilities to be carried out by or on behalf of a public authority without consent.

In determining the revised proposal and degree of impact, Roads and Maritime has considered Sections 111 and 112 of the *Environmental Planning and Assessment Act 1979* and Clause 228 of the Environmental Planning and Assessment Regulation 2000 (refer to **Appendix A** for assessment under Clause 228).

## Environmental impacts

A range of environmental impacts were identified for the upgrade at Forty Bends as part of the original REF. The revised proposal would result in additional environmental impacts, including:

- Biodiversity and fauna connectivity impacts
- Potential heritage impacts
- Urban design and visual impacts.

The revised proposal would also result in some additional positive impacts, including:

- Substantial cost improvements
- Potential safety improvements associated with a reduction in the risk of black ice.

The revised proposal has been assessed against the Neutral or Beneficial Effect (NorBE) Assessment. The assessment found that revised proposal would result in a neutral effect on water quality.

## Management of environmental impacts

A range of additional safeguards and mitigation measures have been proposed to reduce the potential impacts and are detailed in Chapter 5 and Chapter 6.

A number of measures were proposed in the original REF to avoid and minimise potential environmental impacts. These measures, along with additional measures presented in this REF addendum, would be applied as part of the construction and operation of the revised proposal.

## Justification and conclusion

The revised proposal will meet the objectives of the overall Forty Bends upgrade and is anticipated to result in only minor environmental impacts.

The concrete arch design in the revised proposal would provide similar environmental outcomes, substantial cost improvements and reduced risk from black ice compared to the original Whites Creek design.

Roads and Maritime has considered the revised proposal against the potential benefits and impacts, and has determined that the benefits would outweigh the impacts, provided adequate mitigation measures are implemented.

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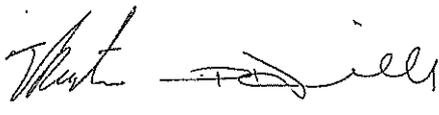
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| Revision | Details                  | Date              | Prepared/amended by        |
|----------|--------------------------|-------------------|----------------------------|
| A        | Original                 | 5 September 2014  | Jarryd Barton, Glyn Diwell |
| B        | Update with RMS comments | 15 September 2014 | Jarryd Barton, Glyn Diwell |
| C        | Update with RMS comments | 16 October 2014   | Jarryd Barton, Glyn Diwell |
|          |                          |                   |                            |
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Signed: 

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Signed: 

Approved by: .....

Signed:

# 1 Introduction

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## 1.1 Background

Roads and Maritime Services (Roads and Maritime) proposes to upgrade the Great Western Highway at Forty Bends, about 5.5 kilometres south of Lithgow. The Forty Bends upgrade proposal (the determined proposal) includes the realignment of about 2.4 kilometres of the Great Western Highway from a point about 280 metres east of the eastern end of Forty Bends Road to a point about 50 metres west of McKanes Falls Road. The proposed upgrade includes construction of new twin five span bridges across Whites Creek.

The Forty Bends upgrade forms part of a series of ongoing upgrades of the Great Western Highway. The Great Western Highway is the main road link between Sydney and Lithgow and beyond to the Central West of New South Wales (NSW). The Forty Bends upgrade is needed to improve the road safety and traffic and freight efficiency along this section of road and would be consistent with other road improvement activities along the Great Western Highway.

A Review of Environmental Factors (REF) was prepared by the Mount Victoria to Lithgow Alliance on behalf of Roads and Maritime in October 2012 and after consideration of submissions from the community, Roads and Maritime determined the proposal in March 2013 for progression to detailed design and construction (the determined REF, Roads and Maritime, 2012a).

As part of the REF, an options assessment for the crossing of Whites Creek was undertaken. The assessment considered two main options, a bridge and an embankment. The options assessment presented in the determined REF (Roads and Maritime, 2012a) identified that the embankment option would result in a substantially larger footprint than the bridge option and would impact Forty Bends Road and a heritage convict-built culvert. The bridge option was also identified as resulting in a reduced overall environmental impact including advantages for hydrology and drainage, biodiversity retention, fauna movement.

After determination of the REF, an alternative to the bridge design was investigated for the crossing of Whites Creek (hereby referred to as the revised proposal) to provide cost improvement, due to a reduction in construction and maintenance costs, and potential safety improvements associated with a reduction in the risk from black ice. Whilst the revised design proposes an embankment, the design of the proposed embankment is different to the previously proposed design and would not result in the same environmental impacts as previously assessed in the determined REF (Roads and Maritime, 2012a).

This REF addendum has been prepared on behalf of Roads and Maritime to describe the changes and assess the potential environmental impacts. This addendum REF describes and assesses only those aspects of the Forty Bends upgrade proposal that are proposed to be modified since the determination of the REF. For consistency and understanding, this addendum should be read in conjunction with the determined REF.

## 1.2 Proposal identification

The revised proposal comprises an alternative to the bridge design for the Whites Creek crossing section of the Forty Bends upgrade. The alternative bridge design consists of a pre-cast concrete arch, earth fill embankment and reinforced earth wall. The revised proposal would utilise the same horizontal and vertical alignment as the previous design.

Full details of the revised proposal are described in Chapter 2.

## 1.3 Need for the proposal

Once of the key considerations of the design outlined in the REF was to address the risk of black ice by moving the alignment of the highway south, further away from the shadow of the steep local topography of Hassan's Wall, immediately north of the Whites Creek site. The black ice risk was successfully mitigated via the design and management measures outlined in the REF by incorporating a concrete pavement wearing course and a bridge heating system.

The revised proposal would substitute the twin bridges with a precast arch and earth embankment which would serve to eliminate the bridge heating element component of the REF design, thereby reducing the complexity and ongoing maintenance issues. The precast arch proposal would address the temperature differential issues by allowing for a continuation of the earth embankments, and concrete pavement. This would lessen the effect of cold air flows, and therefore the risk of black ice developing on the road surface. The additional thickness of ground cover above the arch is also likely to assist in mitigating the potential effects of changes to cold flow characteristics.

The revised proposal would also provide cost improvements due to reduced construction and maintenance costs. At the same time it would provide similar environmental outcomes as the previous bridge design through sensitive design.

## 1.4 Purpose of the REF addendum

This REF addendum has been prepared by the Mount Victoria to Lithgow Alliance (hereafter referred to as 'the Alliance') on behalf of Roads and Maritime to assess possible environmental impacts and to identify any additional management measures required. For the purpose of these works, Roads and Maritime is the proponent and determining authority under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The design for the proposal is currently at concept design stage and the detailed design of the alternative bridge has not been finalised. Should the revised proposal be approved by Roads and Maritime, detailed design of the proposed structure would be undertaken by the nominated contractor to further develop the design of the revised proposal. This REF addendum assesses the potential environmental impacts of the construction and operation of the revised proposal.

The structure of this REF addendum has been prepared to:

- Describe the determined and revised proposal (ie the proposed changes to the Whites Creek crossing component of the Forty Bends proposal since its determination (Chapter 2).
- Consider relevant legislative requirements including any additional environmental planning instruments (Chapter 3).
- Assess the environmental impacts of the revised proposal and detail any additional protective measures that may need to be implemented (Chapters 4 and 5).

This addendum describes and assesses only those aspects of the project that are proposed to be modified since the determination of the REF. For consistency and understanding, this addendum should be read in conjunction with the determined REF (Roads and Maritime, 2012a).

The description of the revised proposal and the associated environmental impacts have been undertaken in the context of clause 228 of the *Environmental Planning and Assessment Regulation 2000* (summarised in Appendix A), the *Threatened Species Conservation Act 1995* (TSC Act), the *Fisheries Management Act 1994* (FM Act), and the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In doing so, the REF addendum helps to fulfil the requirements of Section 111 of the EP&A Act, that Roads and Maritime examines and takes into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the proposal.

The findings of the REF addendum would be considered when assessing:

- Whether the revised proposal is likely to have a significant impact on the environment and therefore the necessity for an environmental impact statement to be prepared and approval to be sought from the Minister for Planning under Part 5.1 of the EP&A Act.
- The significance of any impact on threatened species as defined by the TSC Act and/or FM Act, in Section 5A of the EP&A Act and therefore the requirement for a Species Impact Statement (SIS).
- The potential for the revised proposal to significantly impact a matter of national environmental significance or Commonwealth land and the need to make a referral to the Australian Government Department of the Environment for a decision by the Commonwealth Minister for the Environment on whether assessment and approval is required under the EPBC Act.

## 2 Description of the proposal

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This chapter provides an overview of the determined proposal (section 2.1.) and the revised proposal for an alternative design of the Whites Creek crossing (section 2.2).

### 2.1 The determined proposal

The key features of the determined proposal include:

- Construction of a new road alignment consisting of generally three lanes with two lanes eastbound to the east of Whites Creek and two lanes westbound to the west of Whites Creek.
- Widening of the existing alignment predominantly to the south of the Great Western Highway.
- A central median along the length of the determined proposal of varying widths, ranging up to 9.5 metres.
- Construction of new twin, five-span bridges, about 150 metres in length across Whites Creek.
- Rehabilitation works along the existing alignment of Whites Creek following the removal of the redundant section of the existing highway.
- Upgrades to four existing local road intersections, including two intersections with Forty Bends Road, Daintree Close and McKanes Falls Road, to provide connection to the upgraded highway and property access points.
- New or improved access from the existing highway to nine properties along the length of the determined proposal.
- Closure and relocation of two intersections of Forty Bends Road with the Great Western Highway.
- Five major cuts, 14 metres to 19 metres in height, located on the northern side of the proposed alignment and five major fill embankments, 10 metres to 15 metres in height, located predominantly on the southern side of the proposed alignment.
- Two spilt retaining walls at the following locations:
  - Retaining wall RW52 – between approximate chainages 32080 and 32190 (up to about 110 metres long and up to 9.0 metres high).
  - Retaining wall RW57 – between approximate chainage 32560 and 32725 (up to about 165 metres long and up to 9.0 metres high).
- Removal of about 300 metres of redundant Great Western Highway pavement from about 100 metres east of Whites Creek to about 200 metres west of Whites Creek, and associated culverts.
- Construction of three temporary and five permanent construction basins in addition to temporary access tracks along the length of the determined proposal.
- Measures to mitigate the formation of black ice, including the relocation of the road alignment to the south away from the Hassans Walls escarpment in key locations and an active maintenance program.
- A main compound site located east of the western end of Forty Bends Road, in addition to smaller stockpile areas along the length of the determined proposal during construction.
- A combination of wildlife crossing structures, which would include two fauna underpasses (box culverts), canopy rope bridges at Whites Creek and glider poles located at Whites Creek and near the western fauna underpass.
- Relocation and/or temporary diversion of existing underground utilities including water, powerlines and telephone cables.

A detailed description of the Forty Bends upgrade is provided in the determined REF (refer Chapter 3 of the determined REF).

## 2.2 The revised proposal

The revised proposal comprises an alternative design of the Whites Creek crossing component of the Forty Bends upgrade. The currently determined design for the crossing comprises new twin, five-span bridges, which would span about 150 metres in length across Whites Creek (Roads and Maritime, 2012a, 2012b). The proposed revised design comprises a reinforced earth wall and associated pre-cast concrete arch structure over Whites Creek. Further details of the revised proposal are outlined below.

### 2.2.1 Overview of the revised proposal

The proposed alternative design of the Whites Creek crossing includes a pre-cast concrete arch on piled footings with an earth fill embankment and reinforced earth walls (hereby referred to as the revised proposal).

As per the determined design, the revised design would comprise four lanes over Whites Creek, with two lanes carrying traffic in each direction. The total width of the pre-cast concrete arch structure would be about 51 metres. The road width, shoulders and other associated infrastructure would be consistent with the project outlined in the determined REF (Roads and Maritime, 2012a).

An overview of the revised proposal showing key features and revised construction proposal footprint is shown in Figure 2-1, Figure 2-2 and Figure 2-3.

### 2.2.2 Design of the revised proposal

The revised proposal would include:

- A pre-cast concrete arch structure over Whites Creek, about 17 metres wide, 7.5 metres high and 51 metres long with piled footings. The footings have been proposed to limit the differential settlement across the arch to within 5 millimetres, with the foundations consisting of bored piles on rock with a reinforced concrete capping beam.
- Reinforced earth walls around the lower perimeter of the embankment, particularly around the property boundary to the south of the site, up to about 14 metres high.
- Batter slopes of 2:1 above the wall and 3:1 below the wall.
- Scour protection to protect the arch from any undermining during a flood event.

As part of the revised design, the existing weather monitoring station would be required to be relocated to another suitable location within the determined proposal site for the project.

The revised proposal would not result in any changes to other elements of the determined proposal (as described in the determined REF, Roads and Maritime, 2012a), including elements such as:

- The horizontal and vertical alignment of the road design.
- Proposed drainage.
- Proposed temporary and permanent water quality basins and devices.

- Removal and revegetation of the redundant section of the Great Western Highway to the north of the proposed alignment.

The revised proposal for the Whites Creek crossing would result in a similar area of impact to the determined proposal. A small change to the determined proposal boundary identified in the determined REF would be required to accommodate the revised proposal. The proposed change to the proposal boundary is shown in Figure 2-1.

### 2.2.3 Other design features

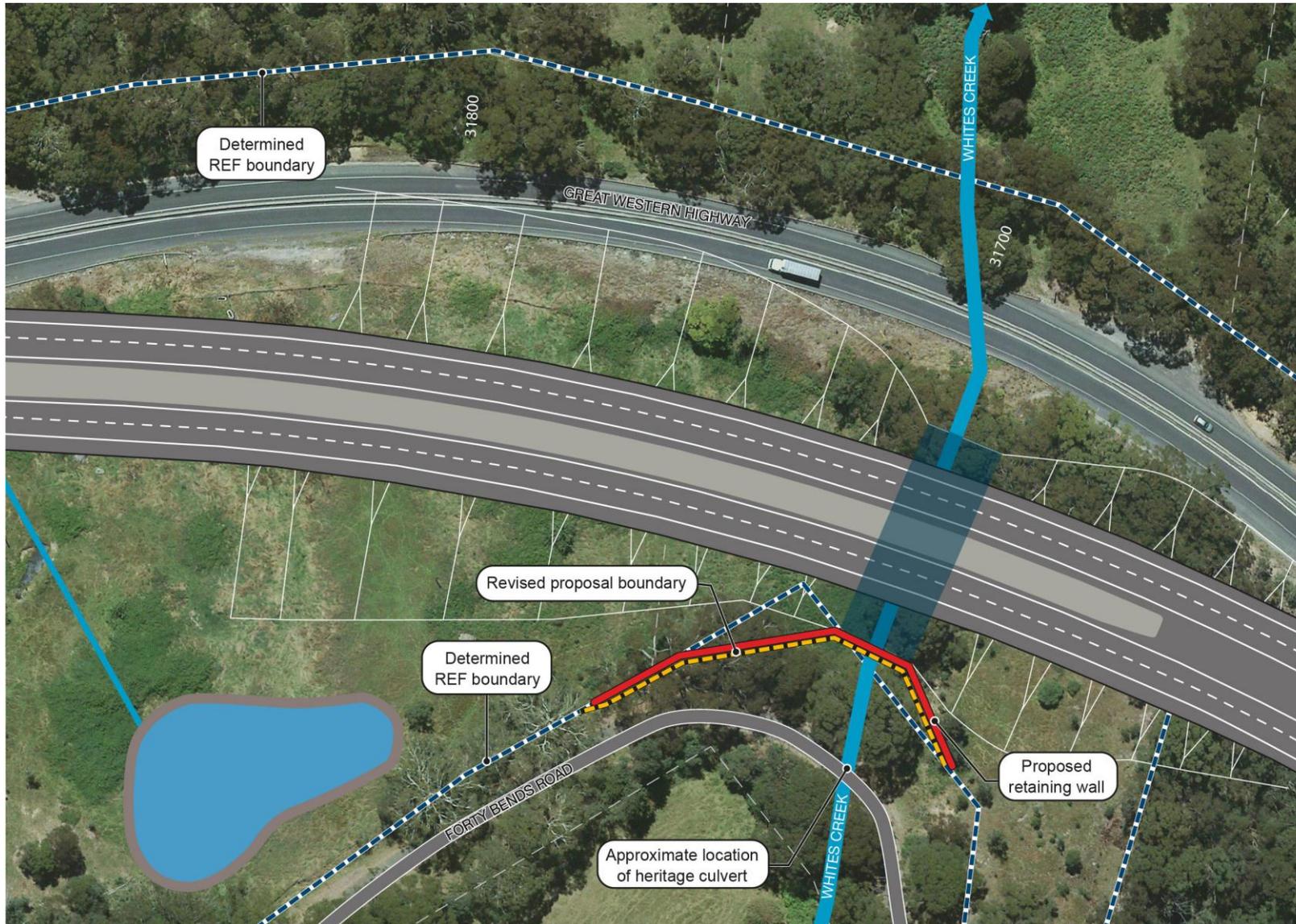
The determined Whites Creek crossing design included a bridge heating system to mitigate potential safety issues associated with black ice and to prevent 'pooling' of cold air on the road surface which assists with the creation of black ice.

The revised proposal does not include the bridge heating system design. Therefore measures included as part of the black ice maintenance program, outlined in section 3.2.5 of the determined REF, would be incorporated within the detailed design to mitigate any risks.

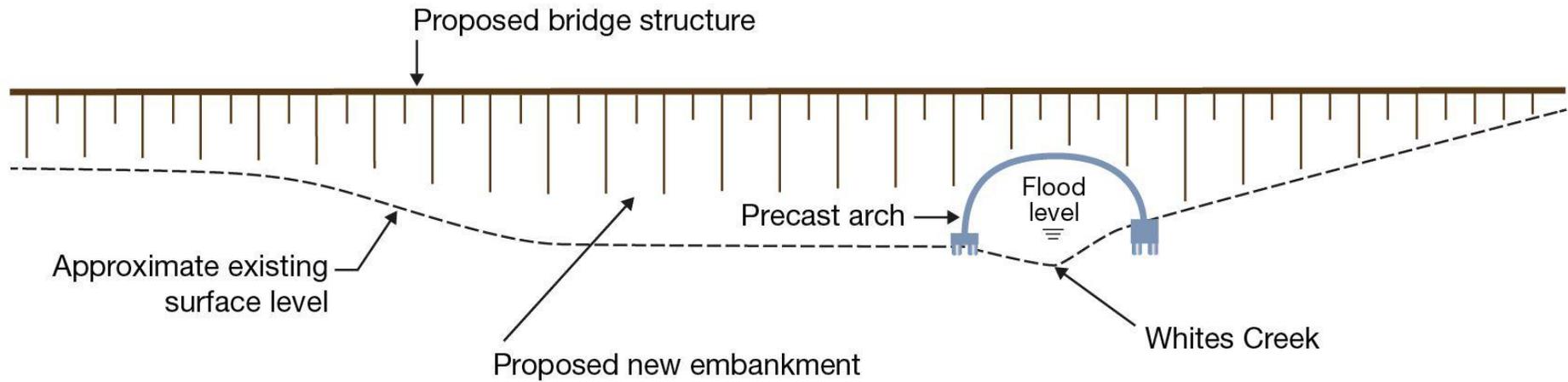
### 2.2.4 Urban design

During development of the concept design for the determined proposal, a number of urban design principles were incorporated into the design to lessen the landscape and visual impact of the proposal and integrate the Whites Creek crossing into the landscape (refer to section 3.2.5 of the determined REF).

These principles would be incorporated within the revised proposal in addition to the safeguard measures proposed in section 5.3.2 of this REF addendum.

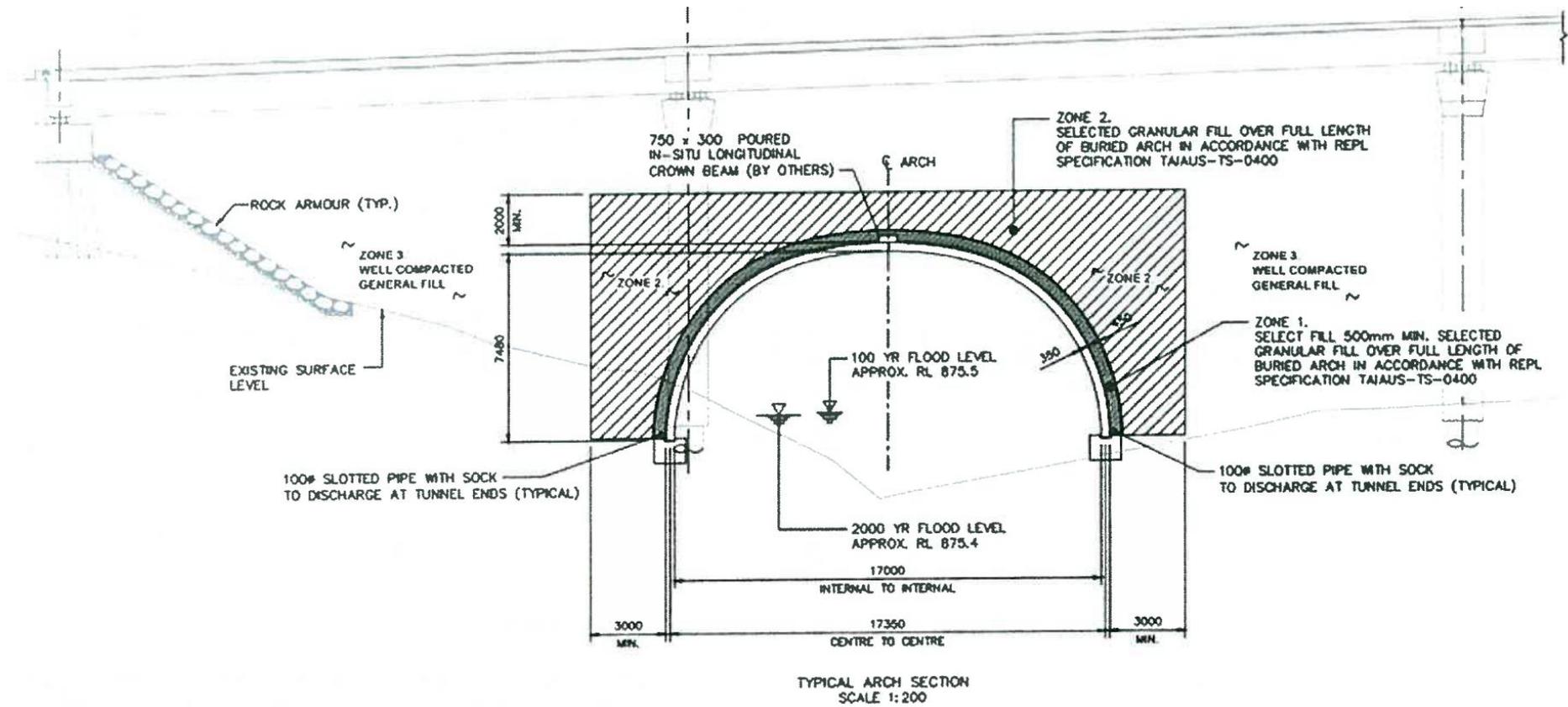


**Figure 2-1: Concept layout of the revised proposal**



*Note: Design is indicative and subject to detailed design*

**Figure 2-2: Concept long section of the revised proposal**



Note: Design is indicative and subject to detailed design

**Figure 2-3: Typical section of the proposed pre-cast concrete arch structure**

## 2.3 Construction activities

### 2.3.1 Work methodology

An indicative methodology and sequencing of activities for the construction of the revised proposal is provided below:

1. Establishment of environmental controls and exclusion zones.
2. Clearing and grubbing.
3. Site preparation including the installation of sediment controls and appropriate safeguard measures to prevent slurry and excavated material from entering the waterway. Protection of Whites Creek would be undertaken by establishment of a crossing point.
4. Preparation of the embankment and reinforced earth wall foundation.
5. Preparation of piling pad and construction of the arch foundations (if required).
6. Installation of pre-cast arch panel. Two half arch segments would be installed concurrently, using separate cranes on each side of the structure.
7. Concurrent construction of embankment, reinforced earth wall and arch backfill
8. Drainage layer – reinforced earth wall blocks would be installed in increments after every metre of completed backfill is placed.
9. Placement of rock and scour protection in front of the pre-cast arch foundations to protect the arch from any undermining during a flood event.
10. Vegetation of the earth embankments and re-vegetation at the pre-cast arch entrance.
11. Installation of new fauna crossing.
12. Select material zone placement.
13. Construction of drainage works.
14. Construction of pavement works.
15. Switch traffic onto new works.

### 2.3.2 Plant and equipment

In addition to the plant and equipment listed in the determined REF (Roads and Maritime, 2012a) (refer to section 3.3.3) the following plant and equipment would be required for construction of the revised proposal:

- *Arch foundations* – piling rig (if required), franna crane, concrete boom pump.
- *Arch installation* – two hydraulic slew cranes, about 150 tonnes in weight.
- *Arch backfill* – 20 tonne hand compaction equipment, CC10 roller.
- *Retaining earth wall* – franna crane, 20 tonne excavator, bogie trucks, hand compaction equipment, smooth drum roller.
- *General earthworks embankment* – 815 compactor, watercart, smooth drum roller, grader, 30 tonne excavator.

### 2.3.3 Construction hours

Construction hours for the revised proposal would be consistent with the construction hours previously described in the determined REF (Roads and Maritime, 2012a, Section 3.3.2).

### 2.3.4 Earthworks

As described in the determined REF, the project has been designed to minimise excess spoil and/or the need to import large quantities of fill. The determined REF identified that the earthworks for the upgrade would require about 134,000 cubic metres of excavation and about 206,000 cubic metres of fill.

The revised proposal is anticipated to require up to about 94,000 additional cubic metres of fill to that which was outlined in the determined REF (Roads and Maritime, 2012a). This would be made up of 12,000 cubic metres for the reinforced earth wall, and 6,000 cubic metres for the arch fill, in addition to other general fill for the embankments.

A summary of the revised earthworks requirements is provided in Table 2.1 below.

**Table 2-1: Comparison of fill requirements between determined and revised proposal designs**

|   | <b>Determined REF design</b>         | <b>Revised proposal design</b>   |
|---|--------------------------------------|--|
| Excavation material generated from proposal | 134,000 cubic metres                 | 134,000 cubic metres   |
| Fill material required                      | 206,000 cubic metres                 | 206,000 cubic metres (determined REF) <b>plus</b> 94,000 cubic metres (revised proposal) |
| <b>Total earthworks excess/deficit</b>      | <b>Deficit – 72,000 cubic metres</b> | <b>Deficit – 166,000 cubic metres*</b>   |

*\* Note: total revised deficit comprises existing determined deficit plus additional deficit generated by the revised proposal.*

### Source of additional fill material

The additional fill materials for the reinforced earth wall, arch fill and embankment are not considered to be in short supply at this time. The locations of each of the potential sources of quarry materials for the revised proposal are consistent with the sites shown on Figure 3-10 of the determined REF (Roads and Maritime, 2012a).

### 2.3.5 Ancillary facilities

No additional stockpile area would be required as part of the revised proposal. It is anticipated that the stockpile and work site compounds identified in the determined REF (Roads and Maritime, 2012a) would be sufficient to meet the requirements of the revised proposal.

### 2.3.6 Traffic management and access

Relative to the determined proposal, construction duration for the overall revised proposal would increase by about 62 days. All truck movements would be via the same routes as required for the determined design, and the rate of supply (ie the number of truck movements per day) would not increase as a result of the alternative pre-cast concrete arch structure design.

As described in the determined REF, the construction of the proposal would result in a temporary increase in heavy vehicle movements along the Great Western Highway and nearby local roads. Construction traffic associated with the proposal at any construction site would generate a range of vehicle type movements including cars, light and heavy trucks and concrete trucks. Construction vehicle traffic would be greatest during the main earthworks and civil construction, and would comprise vehicles transporting equipment, materials and spoil and construction workers accessing the work sites.

As noted in the determined REF, access to the site to construct the revised proposal would be via the Great Western Highway and Forty Bends Road. Where possible, heavy vehicles would be restricted from using local roads such as Forty Bends Road to minimise potential impacts, including potential impacts to identified heritage culverts. These restrictions would be considered as part of the overall construction traffic management plan (CTMP) for the Forty Bends upgrade.

There would be no change to the traffic management proposals provided for the determined design.

## 2.4 Property acquisition

The land acquisition required for the determined proposal was described in section 3.6 of the determined REF (Roads and Maritime, 2012a). Within the vicinity of Whites Creek, the full acquisition of the following lots would be required to accommodate the determined proposal:

- Lot 2 DP 847851.
- Lot 1 DP 847851.

The revised proposal to construct a pre-cast concrete arch structure and associated embankment would not require the acquisition or lease of additional private property. About 170 square metres of additional land currently vested in Lithgow Council would be required to the south of the revised proposal on the northern side of Forty Bends Road (refer to Figure 2-1).

The final requirements for property acquisition and property lease would be identified during detailed design. Discussion with Lithgow Council regarding the requirements to lease and/or acquire the small area of land required would be undertaken during detailed design.

## 3 Statutory and planning framework

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Chapter 4 of the determined REF provided the statutory and planning framework for the proposed upgrade of the Great Western Highway at Forty Bends and considered provisions of the relevant State Environmental Planning Policies (SEPPs), Local Environmental Plans (LEPs) and other NSW legislation.

### 3.1 Relevant legislation

A review of the relevant State and Commonwealth legislation assessed in the determined REF has been undertaken in consideration of the revised proposal (ie the proposed design changes to the Whites Creek crossing). The design changes would not result in any changes to the existing approval pathway presented in the determined REF.

### 3.2 Confirmation of statutory position

All relevant statutory planning instruments have been examined for the revised proposal. It is concluded that the Infrastructure State Environmental Planning Policy (ISEPP) overrides the development consent requirements, thereby permitting assessment of the revised proposal under Part 5 of the EP&A Act.

### 3.3 Guidelines, standards and specifications

The key guidelines and standards relevant to the management of the revised proposal works include:

- Standard Roads and Maritime QA Specifications:
  - R44 Earthworks.
  - G22 Work Health and Safety (Construction Works).
  - G36 Environmental Protection.
  - G38 Soil and Water Management.
  - G40 Clearing and Grubbing.
- Environmental Noise Management Manual – RTA 2001.
- Interim Construction Noise Guidelines, Department of Environment, Climate Change, July 2009.

## 4 Stakeholder and community consultation

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Details regarding the consultation undertaken as part of the Forty Bends upgrade is provided in Chapter 5 of the determined REF.

A review of the correspondence received as part of the exhibition of the determined REF was undertaken during the preparation of this REF addendum. No issues were raised relating to the design of the proposed Whites Creek crossing.

No further consultation has been undertaken as part of the development of this REF addendum.

## 5 Environmental assessment

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This section of the REF provides a detailed description of the potential environmental impacts associated with the construction and operation of the revised proposal. All aspects of the environment potentially impacted upon by the revised proposal are considered. This includes consideration of the factors specified in the guidelines *Is an EIS required?* (DUAP 1999) and *Roads and Related Facilities* (DUAP 1996) as required under clause 228(1)(b) of the *Environmental Planning and Assessment Regulation 2000*. The factors specified in clause 228(2) of the *Environmental Planning and Assessment Regulation 2000* are also considered in Appendix A. Site-specific safeguards are provided to ameliorate the identified potential impacts.

All existing safeguards and mitigation measures outlined in the determined REF would continue to be implemented as part of the revised proposal. In addition, site-specific safeguards are provided in this REF addendum to ameliorate the potential impacts resulting from the revised proposal.

### 5.1 Biodiversity

The determined REF assessed the impacts on threatened flora and fauna of the determined proposal, based on the implementation of specific biodiversity mitigation measures. This included dedicated and combined structures for facilitating fauna movements across the road, for both terrestrial and arboreal mammals.

The biodiversity connectivity strategy for the overall Forty Bends Road Upgrade proposal, as put forward in the determined REF, aimed to mitigate the barrier effect of the highway and road upgrade by including two fauna underpasses, canopy rope bridges at Whites Creek and glider poles located at Whites Creek and near the western fauna underpass.

An ecological technical memorandum (Jacobs, 2014) has been provided in **Appendix B** to assess the impacts of the revised proposal on threatened flora and fauna and to provide any additional safeguards associated with potential impacts.

#### 5.1.1 Potential impacts

##### **Proposed pre-cast concrete arch structure**

Overall, the dimensions of the alternative pre-cast arch structure would provide suitable alternative passage for fauna across the bridge, including the threatened Spotted-tailed Quoll (*Dasyurus maculatus*) and Koala (*Phascolarctos cinereus*), which were assessed as likely to occur in the vicinity of the determined bridge design. These large arch structure types have been proven to provide passage for a range of fauna; although there are some key elements that are required to make them suitably attractive. This would involve vegetation retention and planting at the approaches to the structure, and retaining natural vegetation within the structure or as natural a surface as possible.

Dimensions of the pre-cast arch are large enough for fauna passage (7.4 metres high x 17.0 metres wide), although the extent of rock scour protection required along Whites Creek may reduce the overall internal width down to less than 10 metres creating fauna passage that is dominated by rock. This is compared to the bridge design which allowed at least 100 metres for crossing opportunities and a large amount of light spill under the structure to assist vegetation growth.

This issue is able to be mitigated by designing a minimum of about 3 metres natural bank either side of the creek (refer to section 5.1.2).

### **Proposed earth embankment**

The proposed high batter and retaining walls would provide substantial shading adjacent to the road, particularly on the southern side. This may impact on any existing trees or native vegetation in this location (around the immediate portal area) through a change in micro-climate conditions and is likely to create poor conditions for native vegetation re-growth and any proposed landscape plantings required to assist fauna passage.

### **Fauna connectivity**

It is not anticipated that impacts associated with fauna passage for the target threatened species of the Spotted-tailed Quoll and Koala would change as a result of the revised proposal. The revised proposal may however impact on the opportunity for fauna passage and connectivity for the Yellow-bellied Glider as the existing rope structure, included as part of the determined proposal, would not be possible to be constructed in the same location and specification.

There is a need to review the existing tree survey to determine the best opportunity to place rope structures through the arch to assist in fauna passage. In order for alternative rope crossing structures to be successful, mature remnant trees would need to be identified and retained and their ongoing health protected.

The alternative pre-cast concrete arch structure design would not change the conclusions of the Assessment of Significance for threatened fauna in the determined REF, due to the extent of other mitigation measures incorporated within the overall Forty Bends Road Upgrade proposals. In the event that the rope structure is not feasible, this is not considered to be a significant issue as the main structure for gliders is proposed to be positioned to the west of the bridge where connectivity is optimum and this structure would not be removed by the revised design.

### **Vegetation**

The vegetation adjacent to the existing bridge design was ground-truthed during preparation of the determined REF. This vegetation is identified as disturbed with patches of remnant forest, but no Endangered Ecological Community. Vegetation is dominated by weeds at the Whites Creek crossing site, particularly blackberry, with some isolated trees and small patches of trees. There is unlikely to be a significant change in the impact to existing vegetation associated with the pre-cast arch structure from what was assessed in the determined REF. The trees in proximity to the construction boundary were surveyed and mapped as part of the determined REF concept design, and based on this data up to six trees may need to be cleared to accommodate the revised proposal. From a biodiversity perspective, this change in impact from the determined REF is minimal and does not alter the conclusions of the Assessment of Significance completed for threatened species.

## **Aquatic fauna**

As Whites Creek is an ephemeral drainage line and does not provide habitat for listed threatened species of fish, the revised proposal would not result in additional impact on the habitat for threatened fish species.

### **Purple Copper Butterfly**

The extent of potential habitat for the Purple Copper Butterfly (PCB) was identified and mapped in the determined REF. The revised proposal was overlaid onto the spatial data. This showed that there would be no additional clearing of this habitat to accommodate the revised proposal. Therefore the revised proposal is consistent with the conclusions of the Assessment of Significance for PCB put forward in the determined REF.

A key feature of the habitat for this species is warm basking sites and therefore it is critical that any change to the determined proposal would maintain open sunny habitats for this species where potential habitat was identified. The determined REF identified potential habitat along the slope to the north of the Whites Creek crossing, while high and occupied habitat was identified further west and east of this site. Potential habitat was not identified at the bridge site itself.

The height of the proposed earth embankment may result in shadowing adjacent to the road, compared with the determined proposal design. Shadowing would likely be greater on the south side of the embankment than the north side and there is no potential habitat for the PCB on the south side. There is potential for shadowing on the north side; however any change in light spill onto the northern slope would likely be minimal given the distance of the potential habitat for PCB from the proposed road corridor and the fact that the revised alignment would be moved to the south of the determined alignment and further down slope than the current highway.

The extent of potential habitat identified in the determined REF for PCB in this location was restricted to the road edge which was the limit of the survey. It is likely that this habitat extends further north up to the ridge line across the northern slopes and would be more extensive than mapped in the determined REF with greater distance from the road.

### **Commonwealth referral**

A referral to the Commonwealth for the determined proposal was approved in May 2014 and an offset strategy was prepared to address the potential impacts of the project. The alternate pre-cast concrete bridge design does not alter the conclusions and mitigation measures presented in the referral with respect to the impacts on this species.

#### **5.1.2 Additional safeguards and management measures**

Additional safeguards and management measures for the revised proposal include:

- Scour protection associated with the entries and exits to underpasses must accommodate and provide for the safe and effective passage of fauna, be constructed with the smallest reasonably possible rock size, be as level as possible and have minimal gaps between the rocks. Consideration must be given to the use of concrete paths or other suitable surfaces in the scour protection to provide for the safe and effective passage of fauna.

- The alternative pre-cast concrete arch structure will be designed to incorporate a re-design of the rope crossing structure to traverse through the arch for the passage of fauna. In particular a further site assessment and survey of any outstanding remnant trees may be required to identify opportunities to link the rope structure to remnant forest and not isolated or immature trees.
- A landscape/revegetation management plan will be prepared to detail the requirements for revegetation, adjoining the retaining wall on both sides of the structure. Consideration will need to be given for weed management and site preparation prior to planting. Plant selection will need to consider local species appropriate for the low light conditions on the southern side of the road.
- Natural vegetation will be retained where possible during construction, in particular any remnant trees adjacent to the road corridor.

## 5.2 Non-Aboriginal heritage

The determined REF identified the old line of the 1830's Mitchell's Road running to the south of the determined proposal. This section of road contains the remains of five culverts and cuttings where the road was terraced into the foothill hills of Hassans Walls. Two of the culverts are modern and three contain surviving elements of the original structure.

Culvert 5 (refer to Figure 2-1) is part of a surviving section of the 1830's convict-built Mitchell's Road, and both the culvert and the road have at least local significance.

The northern side of Culvert 5 is a remnant sandstone retaining wall, while the southern side is a modern rebuild. The original section of 1830's Mitchell's Road has been bypassed in this area and the northern side of the culvert is located about 2 metres to the north of the existing Forty Bends Road. Culvert 5 is on the bend where Whites Creek passed beneath the 1830's Mitchell's Road. This area has the characteristics of a 'country lane' typical of surviving segments of the early road.

A Statement of Heritage Impact (Casey and Lowe, 2014) is provided in **Appendix C** of this REF Addendum and provides an assessment of the impacts on Culvert 5 and the 1830's Mitchell's Road and proposes additional safeguards measures associated with the revised proposal.

### 5.2.1 Potential impacts

The footprint of the revised proposal may extend into the easement of the existing Forty Bends Road in the locality of Culvert 5. Culvert 5 is located within the road reserve and a 5 metres buffer has been established between it and the proposed pre-cast arch structure. The height of arch at this point is 7.5 metres. The design option of the arch was investigated with a 10 metre buffer from Culvert 5; however the retaining walls would be about 18 metres high. This was considered to have a greater impact on the surrounding landscape character. Therefore a 5 metre buffer with a lower arch was considered to be more suitable for the landscape character of the country lane and still provide a gap between the culvert and the new design. Also offsetting the location of the arch in relation to Culvert 5 was considered but it would produce a high wall immediately behind the arch and may potentially change the hydrology in the area. This was not considered an acceptable solution.

The revised proposal provides for the retention of the surviving section of Culvert 5 but appears to have a high level of impact on the country lane appearance of the roadway in the area. The embankment is very close to the existing line of Forty Bends Road at the western end and is a few metres from the western end of the road. The proposal is considered likely to have a major visual impact on the significance of this surviving section of Forty Bends Road. The impact on Culvert 5 is minor as the culvert is not intended to be visible in the landscape.

This section of Forty Bends Road is at least of local significance and may potentially be of State significance but such analysis requires further research. The proposal has considerable impact on the significance of Forty Bends Road. It is essential that the road retain this significance following the construction of the new embankment and retaining wall. Therefore the proposed mitigation must ensure not only the retention of Culvert 5 but also the country lane aspect of the road, which is derived from the 1830s road alignment, the narrow width of the road, the mature native trees alongside the road, the road cuttings, as well as glimpses through to the grass paddocks.

### 5.2.2 Additional safeguards and management measures

Additional safeguards and management measures for the revised proposal include:

- Detailed design must ensure that there will be no impact on Culvert 5 or the road during or after construction.
- A curtilage of about 5 metres distance between Culvert 5 and the footprint of the new arch/embankment must be maintained so as not to provide physical and visual dominance over Culvert 5 and the 1830's line of road.
- There should be no impact on Forty Bends Road by the new proposal, either its width, its cutting, and the culverts.
- Mitigation of impacts during construction will involve:
  - Vibration management during construction.
  - Fencing of areas where there should be no impact and to protect the culvert.
  - Resolution of likely urban design issues in relation to this area so as to minimise the visual impact of the new proposal.
- Planting of appropriate trees (to be identified in consultation with RMS biodiversity specialists as part of the detailed design of the revised proposal) to reduce visual impacts along this section of roadway, to maintain the 'country lane' aspect of this roadway.

It is recommended that further assessment of the impacts of the revised proposal should be undertaken during the detailed design phase to determine if the required mitigation necessary to retain significance has been met.

## 5.3 Urban design, landscape and visual amenity

As previously described in the determined REF (refer to section 6.6.2), the study area has been divided into three landscape character zones (LCZs) corresponding to landscape character types.

Each zone was then broken down into a number of different character attributes which were described relative to their existing situation, and as they would be as a result of the determined proposal. The magnitude of the proposed works and the sensitivity of the LCZ to change were then assessed to determine the overall landscape character impact.

The previous study also assessed the potential visual impact of the determined project in relation to 12 identified key viewpoints within an estimated visual catchment. The desktop assessment for the revised proposal has identified that four of these viewpoints would be affected, as described below.

A Landscape Character and Visual Impact Assessment memorandum (Spackman Mossop and Michaels, 2014) is provided in **Appendix D** of this REF Addendum and provides an impact assessment on the landscape character and visual impact associated with the revised proposal and includes additional safeguard measures associated with the revised proposal.

### 5.3.1 Potential impacts

#### **Landscape character impact**

##### *LCZ 2: Whites Creek Valley*

The landscape character assessment identified that the revised proposal would impact on the following attributes within LCZ 2 (refer to Figures 3-1 in **Appendix D**).

- Topography – The revised proposal would require extensive fill embankments and retaining walls up to 14 metres high. This would greatly alter the existing topography by providing an additional built vertical element into the predominantly undulating pasture lands south of the existing highway.
- Hydrology – The existing flow of Whites Creek, the main watercourse and part of Sydney's drinking water catchment, would not be affected. A section of the existing creek (about 51 metres) would be enclosed by the pre-cast concrete arch structure.
- Vegetation – It is estimated that at least six additional mature nature trees would be required to be removed along the northern edge of Forty Bends Road for the construction of the proposed alternative bridge. The increased extent of the proposed embankments would allow additional tree planting in front of the retaining walls which would reduce their impact as the trees mature overtime.
- Spatial quality – The proposed pre-cast concrete arch structure, retaining walls and embankments would slightly increase the sense of enclosure, particularly from Forty Bends Road, compared to the determined proposal. Views to the south over the rolling rural landscape would be maintained.
- Landscape character assessment – The potential impact of the determined design on the Whites Creek Valley LCZ was previously assessed as having moderate sensitivity and a high magnitude, resulting in a high to moderate landscape character impact. The revised proposal would not change the sensitivity rating, which would remain moderate. The proposed changes would maintain the same amount of road pavement as previously assessed. The revised proposal would reduce the size of road infrastructure and would be more in scale with the overall existing landscape character. The extent of the embankments would be greater than the determined design; however, new tree and shrub planting on these would integrate with the embankments over time, with the heavily vegetated slopes of Hassans Walls. The 14 metre high retaining wall around the arch would be out of character with the existing landscape character and would require the removal of additional native trees,

particularly along the boundary of Forty Bends Road, and the initial impacts following construction would be high. The proposed changes would therefore retain the high magnitude rating. The close proximity of the proposed retaining wall to Forty Bends Road will restrict the potential for any tree and shrub planting between the wall and the road, exposing the wall to motorists which will have a high adverse visual impact in this LCZ. The proposed changes would therefore retain the High magnitude rating. Therefore, the overall landscape character impact would remain high to moderate.

## Visual impact

A desktop assessment determined that the following viewpoints would be affected by the revised proposal (refer to Figure 3.2 in **Appendix D**):

- Viewpoint 1.
- Viewpoint 4.
- Viewpoint 5.
- Viewpoint 6.

### *Viewpoint 1:*

Location: Long distance view from the edge of Hassans Walls Lookout, looking west.

Description: The edge of the rock escarpment, south of the Hassans Walls Lookout is a popular public lookout that provides spectacular 270° panoramic views over the dramatic natural and rural landscape of the area. The extent of the site is only a small section of the panorama. The edge of the vegetation that delineates the road corridor is clearly seen from this location.

Viewpoint 1 was previously assessed to have High to Moderate sensitivity and a High to Moderate magnitude, giving a High to Moderate visual impact. The proposed alternative pre-cast concrete arch structure design would not change the sensitivity rating, which would remain High to Moderate.

The changes when viewed from this location and angle would allow for vegetated embankments and planting in the medians. The retaining wall around the northern end of the arch would be visible from this location; however, planted vegetation around this wall would reduce its visibility over time. The changes would reduce the magnitude rating to Moderate. However, the visual impact rating would remain at High to Moderate.

### *Viewpoint 4:*

Location: Foreground view from Great Western Highway, station 31630, looking west.

Description: Within the road corridor, the landscape slopes to the gentle gully of Whites Creek. Good quality Blaxland's Stringybark – Mountain Gum Open Forest is located to the south and Silvertop Ash Open Forest to the north on the slopes of the Hassans Walls escarpment, providing an attractive rural road character, with dappled light and shade and filtered views to the rural landscape to the south. A concrete barrier divides the carriageways.

Viewpoint 4 was previously assessed to have Moderate to Low sensitivity and a High magnitude, giving a High to Moderate visual impact. The alternative pre-cast concrete arch structure design would not change the sensitivity rating, which would remain Moderate to Low. The extent of road pavement, road alignment and amount of tree removal would remain the same; however, would now include a planted median. The proposed embankment planting would provide a sense of enclosure to the highway as the plants mature over time; however, the magnitude rating would remain High. Therefore the visual impact rating would remain High to Moderate.

*Viewpoint 5:*

Location: Foreground view from Forty Bends Road, west of Whites Creek, looking north.

Description: Gently sloping pasture land and rural fencing with scattered tree planting adjacent to Forty Bends Road. Forty Bends Road is an attractive, tree lined, winding rural road with open and forested views. Forty Bends Road also has high heritage values being associated with Mitchell's road, surveyed and built in the 1830's.

Viewpoint 5 was previously assessed to have Moderate sensitivity and a High magnitude, giving a High to Moderate visual impact. The alternative pre-cast concrete arch structure design would not change the sensitivity rating, which would remain Moderate. The reinforced earth walls for the revised proposals would require the removal of up to six additional mature native trees along Forty Bends Road, and the walls and pre-cast arch would be highly visible to motorists travelling along this section of Forty Bends Road. The extent of the embankments would be greater than the determined design; however, new tree and shrub planting to these would integrate the embankments with the heavily vegetated slopes of Hassans Walls from this view over time. The choice of recessive materials and colours would potentially reduce the visibility of the reinforced earth walls and pre-cast arch; however, they would remain highly visible due to the removal of existing mature trees, and due to its immediate proximity to the edge of Forty Bends Road and the lack of space for screen planting. Therefore the magnitude of the proposed works would remain High, and the visual impact rating would therefore remain High to Moderate.

*Viewpoint 6:*

Location: Foreground view from Great Western Highway at intersection of Forty Bends Road, looking east.

Description: Within the road corridor, the landscape slopes down to Whites Creek, and is surrounded by Blaxland's Stringybark – Mountain Gum Open Forest on the slopes to the north and mixed native vegetation community to the south. An existing exposed cutting is located to the northern side of the road. There are attractive mid distance views to Hassans Walls.

Viewpoint 6 was previously assessed to have Moderate to Low sensitivity and a Moderate magnitude, giving a Moderate visual impact. The proposed works would not change the sensitivity rating, which would remain Moderate to Low. The extent of road pavement, road alignment and amount of tree removal would not change. The proposed embankment planting would provide a sense of enclosure to the highway as the plants mature over time; however, the magnitude rating would remain Moderate. Therefore the visual impact rating would remain Moderate.

## Conclusion

The changes to the determined proposal, including the replacement of the five span bridge over Whites Creek with a pre-cast concrete arch would have greater impact to the landscape character and visual impact to those described in the determined REF. The proposed alternative bridge would be a reduction in size and scale than that previously assessed, however the reinforced earth walls would be out of character with the area and would be highly visible when viewed from Forty Bends Road.

The loss of up to six mature trees plus a number of smaller trees along the northern edge of Forty Bends Road would create a highly adverse visual impact on this section of this historic road. The limited potential for any screen planting in front of the wall in its current location, adjacent to the road, would result in this adverse visual impact remaining into the long term. However this adverse impact could be substantially reduced if the pre-cast arch and the reinforced earth walls were relocated away from the edge of Forty Bends Road and if this resulted in the long term protection of the existing roadside vegetation.

The successful establishment of consistent vegetation cover over the embankments adjacent to the arch and the wing walls have the potential to better integrate the revised proposal with the adjoining landscape and the backdrop of Hassans Walls as the planting matures over time.

The assessment of the revised proposal indicates that the rating of the one affected LCZ would remain High to Moderate. Three of the four viewpoints would be slightly affected, although not enough to change the overall visual impact rating. The remaining Viewpoint 5 rating would also remain unchanged despite the magnitude being greater, as the magnitude rating assessed in the REF was already High.

The assessment has been based on available information, and the incorporation of the proposed safeguard and management measures outlined below in section 5.3.2.

### 5.3.2 Safeguards and management measures

During the concept design stage of the determined project, a number of mitigation measures were incorporated into the design to lessen the visual impact of the revised proposal and to help integrate the Whites Creek bridge into the landscape. These included:

- Retaining roadside vegetation where possible.
- Revegetation, based on existing vegetation communities (including grasses, groundcovers, shrubs, riparian species, and trees depending on sight line requirements), in medians and roadside areas to help reduce perceived corridor width.
- Designing the revised crossing over Whites Creek and associated earthworks to minimise impacts on the creek bed, banks and vegetation.
- Minimising the depth of the structure to reduce the visual impact of the bridge from surrounding areas. The number of bridge piers should be minimised to keep views through and across the bridge as open as possible. The tapering of the piers would give them a 'finer' appearance.

The following additional safeguards and mitigation measures should also be considered and incorporated into the revised design during the detailed design process:

- Design of the revised proposal must have an integrated engineering, urban design and biodiversity outcome.
- Design must minimise the visual impact of hard elements associated with the size and extent of the retaining wall, earth embankment and culvert structure. The design of the revised proposal will address the following:
  - Consider sloping the underpass portal opening to match the gradient of the slope and revegetate the surrounding embankment (refer to Figure 4-1 in Appendix D).
  - Consider reducing the height and scale of the reinforced earth walls by terracing, and/or changing the angle of the wingwall (the implementation of this measure may be dependent on liaison with adjoining landowners).
  - Integrate the new embankments into the adjoining landform to minimise their visual contrast with the existing landscape.
  - Providing revegetation on the new embankments to visually integrate them with the heavily vegetated slopes of Hassans Walls.
  - Protect the primary root zones of existing roadside trees outside of the revised proposal footprint, particularly those along Forty Bends Road.
  - Continue shrub and groundcover planting to the median over the proposed pre-cast concrete arch structure and embankment to reduce the extent of hard surface and to help reduce perceived corridor width.
  - Consider visually recessive materials, textures and colours, such as black oxide or pre-cast concrete panels with exposed basalt aggregate finish to the reinforced earth walls and pre-cast concrete arch structure (refer to Figure 4-2 in Appendix D).
  - Place large boulders in a random formation in front of the foundations (whilst considering the ecological requirements outlined in section 5.1.2) to reduce scour, using rock excavated from the site, otherwise use a grey basalt rock.

It is recommended that the following measures should be considered during detailed design in conjunction with the safeguard and management measures outlined above:

- Provide additional planting along the verge between the reinforced earth walls and Forty Bends Road to provide screening of the wall to motorists travelling along Forty Bends Road.
- Commission an arborist to work with the design team to ensure that appropriate protection measures are put in place for the existing trees along Forty Bends Road.

## 5.4 Other environmental issues

As part of the environmental assessment of the determined proposal, a number of other environmental impacts were considered.

Table 5-1 provides a summary of these other environmental issues as previously identified in the determined REF, and assessment of the potential change in impacts resulting from the proposed alternative design for the Whites Creek crossing.

**Table 5-1: Summary of other environmental impacts**

| Environmental issue | Potential impacts identified as part of the determined REF   | Additional impacts resulting from the alternative pre-cast concrete arch structure design?  |
|---------------------|--|---|
| Water and soils     | <p>A range of water and soil impacts were identified as part of the determined REF including:</p> <ul style="list-style-type: none"> <li>• General earthworks, including stripping of topsoil, excavation or raising, handline of larger volumes of fill and exposure of large earth embankments on a slope.</li> <li>• Stockpiling of topsoil and vegetation.</li> <li>• Transportation of cut and/or fill materials.</li> <li>• Movement of heavy vehicles across exposed earth.</li> <li>• Removal of riparian vegetation.</li> <li>• Construction in steep areas.</li> <li>• Construction in areas upstream of sensitive receiving environments.</li> <li>• Construction in erodible areas, currently assessed as being moderately erodible.</li> <li>• Leaks or spills from chemicals or fuels used during the construction of the revised proposal.</li> <li>• Construction of the alternative pre-cast arch structure and earth embankments across Whites Creek leading to water quality impacts from run-off of spoil material and increases in sediment entering and polluting the waterway.</li> </ul> <p>These impacts were considered to be sufficiently mitigated by the safeguards and mitigation measures that were identified in the determined REF.</p> | <p>The potential impacts at the crossing of Whites Creek would be contained within a slightly increased footprint to the proposal footprint described and assessed in the determined REF (refer to section 2.4.1 of this REF addendum). It is not anticipated that the proposed design change to the creek crossing would result in additional impacts to water and soils to those identified and assessed in the determined REF.</p> <p>The existing White Creek is on a significant grade. The 1:100 year flood level is the same as the 1:2000 year level, so no flooding or hydrological issues are perceived. The flow through the creek is constrained upstream of the proposed bridge by an existing two 1200 millimetre diameter culverts that would remain intact.</p> <p>Downstream flow is via the existing heritage culvert that would remain unaffected by the alternative bridge design.</p> <p>Protection of Whites Creek during construction would be undertaken by establishment of a crossing point to allow for protected movement of vehicles and equipment across the existing creek line.</p> <p>Scour protection would be placed in front of the foundations to protect the arch from any undermining during a flood event and preventing increased sediment deposition resulting in impacts to water quality.</p> |

| Environmental issue | Potential impacts identified as part of the determined REF  | Additional impacts resulting from the alternative pre-cast concrete arch structure design?  |
|---------------------|---|---|
|                     |   | <p>The alternative pre-cast concrete arch structure design has also been assessed against the Neutral or Beneficial Effect (NorBE) Assessment undertaken as part of the determined REF (Roads and Maritime, 2012a). The revised design is considered to be consistent with the findings and conclusions of the previous NorBE assessment which concluded that the revised proposal would result in a neutral effect on water quality due to the proposed water quality mitigation measures (such as water quality basins) which were proposed as part of the determined REF.</p> <p>Additionally, with respect to potential soil impacts, it is noted that the revised design would require up to an additional 94,000 cubic metres of additional earthworks. It is considered that the mitigation and management measures presented in the determined REF (Roads and Maritime 2012a) are adequate to manage the impacts of the revised design.</p> |
| Aboriginal heritage | An Aboriginal and Cultural Heritage Assessment was undertaken as part of the determined REF. This assessment identified two Aboriginal heritage sites within the vicinity of the Forty Bends upgrade. | <p>One of the previously identified Aboriginal sites (FB 1) is located about 100 metres to the east of the Whites Creek crossing location.</p> <p>This site would not be impacted by the proposed design change to the Whites Creek crossing and impacts to this site would be managed in accordance with the mitigation measures previously outlined in the determined REF.</p>  |

| Environmental issue   | Potential impacts identified as part of the determined REF   | Additional impacts resulting from the alternative pre-cast concrete arch structure design?   |
|-----------------------|--|--|
| Noise and vibration   | <p>A range of noise and vibration impacts were identified as part of the determined REF including impacts from:</p> <ul style="list-style-type: none"> <li>• Construction equipment and plant.</li> <li>• Construction traffic.</li> <li>• Construction compounds and stockpiles.</li> <li>• Construction vibration impacts.</li> <li>• Out of hours construction works.</li> <li>• Operation of the road.</li> </ul>  | <p>The noise and vibration impacts and mitigation measures are unlikely to substantially change as a result of the alternative pre-cast concrete arch structure design at Whites Creek during construction or operation of the revised proposal design.</p> <p>A Construction and Noise and Vibration Management Plan (CNVMP) will be prepared which will detail how noise and vibration impacts will be minimised.</p> <p>Potential vibration impacts to the existing culvert along Forty Bends Road would be managed in accordance with the existing management measure NV-17 identified in the determined REF (Roads and Maritime, 2012a) which notes that <i>'a condition assessment survey is required to assess and identify appropriate construction vibration levels and mitigation measures'</i> where structures such as the culvert are identified.</p> |
| Traffic and transport | <p>A range of traffic and transport impacts were identified as part of the determined REF including:</p> <ul style="list-style-type: none"> <li>• Construction traffic volumes and road performance.</li> <li>• Intersection performance.</li> <li>• Transport of excavated material and imported fill.</li> <li>• Over-dimension vehicles.</li> <li>• Construction access.</li> <li>• Detours or alternative routes.</li> <li>• Increased travel times.</li> <li>• Road performance and safety benefits.</li> <li>• Traffic performance.</li> </ul> <p>These impacts were considered to be sufficiently mitigated by the safeguards and mitigation measures that were identified in the determined REF.</p> | <p>It is not anticipated that the alternative pre-cast concrete arch structure design would result in an increase to the daily construction traffic movements identified in the determined REF. The duration of the construction of the alternative bridge will increase to account for an increase in earth movements.</p> <p>The proposed transport and traffic mitigation measures would be detailed in the overall project construction traffic management plan (CTMP) and traffic control plan (TCP). It is considered that the revised design would not result in any changes to property access along Forty Bends Road that are inconsistent with the determined proposal (Roads and Maritime 2012a, 2012b). The CTMP and TCP would include provisions for maintaining access to existing properties along Forty Bends Road.</p>                            |

| Environmental issue | Potential impacts identified as part of the determined REF  | Additional impacts resulting from the alternative pre-cast concrete arch structure design?   |
|---------------------|---|--|
|                     |   | Where possible, heavy vehicles would be restricted from using local roads such as Forty Bends Road to minimise potential impacts, including potential impacts to identified heritage culverts. These restrictions would be considered as part of the overall construction traffic management plan (CTMP) for the Forty Bends upgrade.  |
| Air quality         | <p>There is a potential for dust to be generated during vegetation removal, excavation and the construction of the Forty Bends upgrade. In addition, exhaust from plant and equipment may impact air quality in the short term during construction operations.</p> <p>Dust and exhaust generation are expected to be minimal and localised and would result in minimal to no impacts on existing air quality.</p> | <p>Trucks entering and leaving the site that are carrying dust generating loads (such as for the additional fill material required for the reinforced earth wall) may generate some additional dust.</p> <p>As described in the determined REF, control measures would be included in the CEMP to ensure dust emissions are suitably managed such that air quality impacts at nearby sensitive receptors are minimised.</p> <p>Dust monitoring would occur in accordance with the Project's Air Quality Management Plan.</p> |

| Environmental issue           | Potential impacts identified as part of the determined REF   | Additional impacts resulting from the alternative pre-cast concrete arch structure design?   |
|-------------------------------|--|--|
| Waste and resource management | <p>A range of waste and resource management impacts were identified as part of the determined REF including:</p> <ul style="list-style-type: none"> <li>• Demand on resources: <ul style="list-style-type: none"> <li>○ Materials required for road surfaces including asphalt, concrete, aggregate and other fill materials.</li> <li>○ Materials required for bridge construction such as concrete and steel reinforcing.</li> <li>○ Construction water.</li> </ul> </li> <li>• Waste: <ul style="list-style-type: none"> <li>○ Construction waste materials (including packaging, concrete, bricks, crushed rock, steel and timber).</li> <li>○ Liquid wastes (including waste fuels, paints, oils and chemicals).</li> <li>○ Wastewater (including site run-off and water used to control dust).</li> <li>○ Surplus materials used during site establishment (including safety fencing and barriers, which may include plastics and metals).</li> <li>○ Domestic wastes (including food scraps and putrescible wastes, aluminium cans, glass bottles, plastic and paper containers used by construction workers), construction site facilities.</li> </ul> </li> </ul> <p>These impacts were considered to be sufficiently mitigated by the safeguards and mitigation measures that were identified in the determined REF.</p> | <p>The alternative pre-cast concrete arch structure design would require an additional 94,000 cubic metres of fill material including 12,000 cubic metres for the retaining wall and 6,000 cubic metres for the arch select fill.</p> <p>Although there will be an increase in the requirement for fill material, the overall Forty Bends Road Upgrade proposal has been designed to minimise excess spoil and/or the need to import large quantities of fill.</p> <p>Whilst the construction of the determined proposal would increase demand on local and regional material resources, the development of the alternative pre-cast concrete arch structure design alone would not result in any resource becoming scarce or in short supply within the local or greater regional area.</p> <p>Resource requirements, particularly for water and construction materials would be determined during the detailed design and construction phase.</p> <p>No additional impacts to waste and resources would occur from the revised proposal additional to those identified and assessed in the determined REF.</p> |

| <b>Environmental issue</b>       | <b>Potential impacts identified as part of the determined REF</b>   | <b>Additional impacts resulting from the alternative pre-cast concrete arch structure design?</b>  |
|----------------------------------|---|--|
| Cumulative environmental impacts | <p>A range of potential cumulative impacts were identified as part of the determined REF including:</p> <ul style="list-style-type: none"> <li>• The interaction of individual elements within the revised proposal and surrounds.</li> <li>• The additive effects of the proposal with other external projects.</li> <li>• The additive effects of the revised proposal with other road upgrade projects in the Blue Mountains.</li> </ul> <p>These impacts were considered to be sufficiently mitigated by the safeguards and mitigation measures that were identified in the determined REF.</p> | No additional cumulative impacts other than those identified in the determined REF are anticipated to occur as a result of the proposed alternative pre-cast concrete arch structure design. |

## 6 Environmental management

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### 6.1 Environmental management plans (or system)

As part of the determined REF, a series of environmental safeguards and management measures were detailed to manage the identified environmental issues that would occur as a result of the Forty Bends upgrade. These safeguards and management measures formed a framework for managing the identified potential impacts with reference to environmental management plans and relevant Roads and Maritime QA specifications.

The environmental safeguards and management measures for the Forty Bends upgrade are presented in Table 7-1 of the determined REF.

The Project Environmental Management Plan (PEMP) and the Contractors Environmental Management Plan (CEMP) will be prepared to describe safeguards and management measures identified in both the determined REF and this REF addendum. These plans will provide a framework for establishing how these measures will be implemented and who would be responsible for their implementation.

The plans will be prepared prior to construction of the revised proposal and must be reviewed and certified by the Roads and Maritime Environmental Officer, Western Region, before commencement of any on-site works. The CEMP will be a working document, subject to ongoing change and updated as necessary to respond to specific requirements.

### 6.2 Summary of safeguards and management measures

The environmental safeguards and management measures presented in the determined REF would continue to apply to the revised proposal (ie the proposed alternative pre-cast concrete arch structure design at Whites Creek).

Additional safeguards which have been identified as a result of the environmental assessment undertaken as part of this REF addendum have also been incorporated into the existing safeguard measures. The additional safeguards have been provided in Table 6-1 and are shown as *red highlights*. These safeguards would minimise any potential adverse impacts arising from the revised proposal.

### 6.3 Licensing and approvals

Should Roads and Maritime determine to proceed with the revised proposal, no additional approvals and/or licences have been identified that would be required prior to commencement (other than those previously identified in the determined REF).

At this stage, it is not envisaged that an environmental protection licence (EPL) would be required for the revised proposal under the provisions of the *Protection of the Environment Operations Act 1997* (POEO Act).

It is also noted that, should any additional road projects be constructed at the same time and that directly adjoin the Forty Bends upgrade, consideration of the requirement for an EPL under clause 35 of Schedule 1 of the POEO Act would need to be undertaken to determine whether the project would require an EPL.

**Table 6-1: Summary of site specific environmental safeguards**

| Ref #          | Impact  | Environmental safeguards  | Responsibility                                   | Timing  |
|----------------|---------|---|--|---|
| <b>General</b> |         |   |  |   |
| G-1            | General | <ul style="list-style-type: none"> <li>• All environmental safeguards must be incorporated within the following documents:               <ul style="list-style-type: none"> <li>○ Project Environmental Management Plan.</li> <li>○ Detailed design stage.</li> <li>○ Contract specifications for the proposal.</li> <li>○ Contractor’s Environmental Management Plan.</li> </ul> </li> </ul>   | Project manager                                  | Pre-construction                                      |
| G-2            | General | <ul style="list-style-type: none"> <li>• A risk assessment must be carried out on the proposal in accordance with the RMS Audit Pack and OSD risk assessment procedures to determine an audit and inspection program for the works. The recommendations of the risk assessment are to be implemented.</li> <li>• A review of the risk assessment must be undertaken after the initial audit or inspection to evaluate if the level of risk chosen for the proposal is appropriate.</li> <li>• Any works resulting from the proposal and as covered by the REF may be subject to environmental audit(s) and/or inspection(s) at any time during their duration.</li> </ul> | Project manager and regional environmental staff | Pre-construction<br><br>After first audit             |
| G-3            | General | <ul style="list-style-type: none"> <li>• The environmental contract specification must be forwarded to the RMS Senior Environmental Officer for review at least 10 working days prior to the tender stage.</li> <li>• A contractual hold point must be maintained until the CEMP is reviewed by the RMS Senior Environmental Officer.</li> </ul>  | Project manager                                  | Pre-construction                                      |
| G-4            | General | <ul style="list-style-type: none"> <li>• The RMS Project Manager must notify the RMS Environmental Officer Western Region at least 5 days prior to work commencing.</li> </ul>  | Project manager                                  | Pre-construction                                      |
| G-5            | General | <ul style="list-style-type: none"> <li>• All businesses and residences likely to be affected by the proposed works must be notified at least 5 working days prior to the commencement of the proposed activities.</li> </ul>  | Project manager                                  | Pre-construction                                      |
| G-6            | General | <ul style="list-style-type: none"> <li>• Environmental awareness training must be provided, by the contractor, to all field personnel and subcontractors.</li> </ul>  | Contractor                                       | Pre-construction and during construction as required. |

| Ref #               | Impact                         | Environmental safeguards  | Responsibility          | Timing           |
|---------------------|--------------------------------|---|-------------------------|------------------|
| <b>Biodiversity</b> |                                |   |                         |                  |
| BI-1                | Vegetation and habitat removal | <p>Undertake a pre-clearing survey as follows to determine the presence of flora and fauna species and habitats within the proposal site:</p> <ul style="list-style-type: none"> <li>• Surveys would be undertaken by an experienced ecologist to identify the location and extent of important habitats in the proposal site to be salvaged for reuse/relocation, such as bushrock, hollow trees and woody debris.</li> <li>• Surveys would be conducted for Purple Copper Butterfly by a suitably qualified expert during the adult flying and juvenile larval seasons (September and October-November, respectively) and appropriate protection/management measures would be implemented if the species is present in or directly adjacent to the proposal site.</li> <li>• Habitat features to be protected during construction would be identified and recorded in the Vegetation Management Plan.</li> <li>• The project ecologist would identify areas for releasing animals encountered during the pre-clearing process or habitat removal process. The areas would be clearly identified in the Flora and Fauna Management Plan before clearing commences.</li> <li>• Determine the need, number and type of nest boxes required post construction based on the number, quality and size of the hollows that would be removed from the proposal site and the availability of habitat within the adjoining areas.</li> <li>• Confirm planning and procedures for the staged habitat removal process in accordance with RMS Biodiversity Guidelines (RTA 2011).</li> </ul> | Construction contractor | Pre-construction |

| Ref # | Impact                         | Environmental safeguards  | Responsibility          | Timing                                       |
|-------|--------------------------------|---|-------------------------|--|
| BI-2  | Vegetation and habitat removal | <p>Include the following safeguards in the CEMP:</p> <ul style="list-style-type: none"> <li>• Maps identifying the location of threatened ecological communities, habitat and fauna species on sensitive area maps.</li> <li>• An unexpected threatened species finds procedure as specified in the RMS Biodiversity Guidelines (RTA 2011).</li> <li>• The location of exclusion zones, where practical installed prior to clearing, to avoid damage to native vegetation and fauna habitats and prevent the distribution of pests, weeds and disease. Temporary fencing would be installed to indicate the limits of clearing. The location and type of exclusion fencing to be installed would be identified on plans in the CEMP. A staged habitat removal process would be implemented consistent with the procedures identified in the RMS Biodiversity Guidelines (RTA 2011). The staged habitat removal process would be incorporated into the CEMP and communicated to construction personnel.</li> <li>• Topsoil within areas of native vegetation would be retained and stockpiled for use in rehabilitation activities.</li> </ul> | Construction contractor | Pre-construction, construction               |
| BI-3  | Vegetation and habitat removal | <ul style="list-style-type: none"> <li>• A Vegetation Management Plan would be developed which provides specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction.</li> <li>• Opportunities would be sought within the Vegetation Management Plan to include vegetation sympathetic to the habitat requirements of the r Purple Copper Butterfly, by incorporating the larvae-feed species Blackthorn (<i>Bursaria spinosa</i> subsp. <i>lasiophylla</i>) and creating and maintaining open sunny habitats.</li> </ul>  | Construction contractor | Pre-construction, construction and operation |
| BI-4  | Vegetation and habitat removal | <p>Re-use of woody debris and bushrock.</p> <ul style="list-style-type: none"> <li>• The Vegetation Management Plan in accordance with RMS Biodiversity Guidelines (RTA 2011) would outline the details of potential re-use of woody debris and bushrock on site for habitat improvement.</li> </ul>  | Construction contractor | Pre-construction, Construction               |

| Ref # | Impact  | Environmental safeguards  | Responsibility                  | Timing                                    |
|-------|---|---|---------------------------------|---|
| BI-5  | Vegetation and habitat removal  | <p>Nest boxes would be installed to compensate for loss of hollow-bearing trees from the proposal site.</p> <ul style="list-style-type: none"> <li>• A nest box management strategy would be developed as part of a Fauna Management Plan. The need, number and type of nest boxes required would be determined during the pre-clearance surveys based on the number, quality and size of the hollows that would be removed.</li> </ul>   | Construction contractor         | Pre-construction, construction, operation |
| BI-6  | Injury and mortality of fauna during the clearing of vegetation and drainage of farm dams | <p>An experienced and licensed wildlife carer and/or ecologist would be present to supervise vegetation clearing and capture and relocate fauna where required. Fauna handling and vegetation clearing would be undertaken in accordance with the procedures provided in the RMS Biodiversity Guidelines (RTA 2011).</p>  | RMS/<br>Construction contractor | Pre-construction, Construction            |
| BI-7  | Spread of weeds   | <p>Actions for weed management would be developed as part of the Vegetation Management Plan. The plan would include, but not be limited to, the following measures for weed management:</p> <ul style="list-style-type: none"> <li>• Taxa and potential sources of the weed species.</li> <li>• Weed management priorities and objectives.</li> <li>• Sensitive environmental areas within or adjacent to the site.</li> <li>• Location of weed infested areas.</li> <li>• Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance.</li> <li>• Measures to prevent the spread of weeds.</li> <li>• A monitoring program to measure the success of weed management.</li> <li>• Communication strategies to improve contractor awareness of weeds and weed management.</li> </ul> | Construction contractor         | Pre-construction                          |

| Ref # | Impact  | Environmental safeguards   | Responsibility          | Timing                                    |
|-------|---|--|-------------------------|---|
| BI-8  | The introduction and/or spread of pests and disease causing agents such as bacteria and fungi | <p>Measures would be implemented to prevent the introduction and/or spread of pests and disease causing agents such as bacteria and fungi.</p> <p>As provided in the RMS Biodiversity Guidelines (RTA 2011), methods to be implemented for this proposal include:</p> <ul style="list-style-type: none"> <li>• Provide vehicle and boot wash down facilities and ensure vehicles and footwear is free of soil before entering or exiting the site.</li> <li>• The risk of spreading pathogens and the mitigation measures required on site should be regularly communicated to staff and contractors during inductions and toolbox talks.</li> <li>• Construction works would be programmed to move from uninfected areas to any known infected areas.</li> <li>• Restrict vehicles to designated tracks, trails and parking areas.</li> <li>• The above pathogen management measures need to be implemented throughout the entire construction period.</li> </ul> | Construction contractor | Pre-construction, construction, operation |
| BI-9  | Loss of wildlife connectivity   | <p>The bridge structure over Whites Creek would include the following ecologically sensitive design principles during development of detailed design, where practicable:</p> <ul style="list-style-type: none"> <li>• The bridge would be designed with a natural substrate at the abutment, such as sediment or vegetation.</li> <li>• The bridge would be designed to allow unimpeded water flow, stream bank and riparian vegetation on both sides of the water course.</li> <li>• Large woody debris is to be retained within watercourses and/or re-use of salvaged woody debris, where possible.</li> <li>• The bridge would be designed, (height, carriageway separation) to allow sufficient light and moisture to encourage growth of vegetation under the structures.</li> </ul>   | RMS                     | Pre-construction, construction            |

| Ref # | Impact                                  | Environmental safeguards   | Responsibility          | Timing                                    |
|-------|---|--|-------------------------|---|
| BI-10 | Loss of wildlife connectivity           | <p>Ecologically sensitive design of underpass structures would include:</p> <ul style="list-style-type: none"> <li>• Two culverts to maintain north-south connectivity across the landscape (refer to <b>Figure 6-6</b>).</li> <li>• Habitat within a culvert is to be as natural as possible (eg allow rocks and bed materials to infill the culvert base).</li> <li>• Provision of appropriate shelter for wildlife to encourage use and reduce risk of predation.</li> <li>• Native vegetation is to be provided at the entrances to provide shelter for wildlife and to encourage use.</li> <li>• Glider poles to be installed as part of the western fauna underpass.</li> </ul>  | RMS                     | Pre-construction, construction            |
| BI-11 | Use of wildlife connectivity structures | <p>Installation of fauna fencing.</p> <ul style="list-style-type: none"> <li>• Fencing would be integrated with the crossing structures (underpasses) by guiding animals towards the crossing structure and preventing access to the road.</li> <li>• Fencing would be constructed about 100 m each side of the fauna crossing on both sides of the road.</li> <li>• Fencing would be continuous and at their ends have a 'return area' to guide animals back into habitat rather than onto the road.</li> <li>• The size of the mesh must prevent the target species from climbing through.</li> <li>• The fence would prevent animals from digging underneath.</li> <li>• Fencing would be a floppy-top style to prevent animals from climbing or jumping over.</li> <li>• Fauna fencing would not endanger wildlife (eg barbed wire must not be used as birds, bats and gliders become entangled and die).</li> <li>• Escape mechanisms would be provided to allow animals to exit the fenced area.</li> <li>• Maintenance of fencing is critical to identify and repair breaches, periodic inspections are likely to be required.</li> </ul> | Construction contractor | Pre-construction, construction, operation |

| Ref # | Impact                        | Environmental safeguards   | Responsibility          | Timing                         |
|-------|-------------------------------|--|-------------------------|--------------------------------|
| BI-12 | Loss of wildlife connectivity | <p>Prior to construction, as part of the development of the detailed design for the proposal the following would be confirmed:</p> <ul style="list-style-type: none"> <li>• Locations for all crossing structures would be confirmed during detailed design.</li> <li>• The locations of trees that would need to be retained to install crossing structures.</li> </ul>   | RMS                     | Pre-construction               |
| BI13  | Loss of wildlife connectivity | <p>Construction of canopy bridges and glider poles:</p> <ul style="list-style-type: none"> <li>• A canopy bridge is proposed to be constructed beneath the proposed Whites Creek bridge structure, which would be constructed to below parameters (refer to <b>Figure 6-6</b>): <ul style="list-style-type: none"> <li>○ Minimum 6.0 metres above the ground.</li> <li>○ The canopy bridge is to be attached to suitable poles. The exact location of the poles is to be determined at the final design stage and should consider the use of targeted nocturnal glider surveys and habitat trees surveys in the area.</li> <li>○ Canopy bridges must be linked to adjacent habitat for target species (eg habitat trees) via ropes or ladders tied off from the poles into surrounding trees. Nearby trees are essential to link the canopy bridge into the surrounding vegetation.</li> <li>○ Glider poles would also be installed at this location.</li> </ul> </li> </ul> | Construction contractor | Pre-construction, construction |
| BI-14 | Loss of wildlife connectivity | <p>Rehabilitation strategies would be included in the Vegetation Management Plan for the proposal and include:</p> <ul style="list-style-type: none"> <li>• The protection of riparian corridors during construction works and the rehabilitation of any areas of riparian vegetation impacted by construction.</li> <li>• Consideration of the height and density of re-planted vegetation so as not to screen crossing structures from view, while also providing some cover for fauna approaching and exiting the structure.</li> </ul>   | Construction contractor | Construction, operation        |
| BI-15 | Biodiversity offset strategy  | <p>A biodiversity offset strategy would be developed to compensate for the proposed impacts from the proposal. One potential offset location has been identified at South Bowenfels which supports a population of Purple Copper Butterfly. Further assessment and negotiation would be required to establish an appropriate biodiversity offset. This assessment and negotiation would occur during development of the detailed design.</p>   | RMS                     | Pre-construction               |

| Ref #                      | Impact                                  | Environmental safeguards   | Responsibility          | Timing           |
|----------------------------|---|--|-------------------------|------------------|
| BI-16                      | Loss of wildlife connectivity           | <ul style="list-style-type: none"> <li>Scour protection associated with the entries and exits to underpasses must accommodate and provide for the safe and effective passage of fauna, be constructed with the smallest reasonably possible rock size, be as level as possible and have minimal gaps between the rocks. Consideration must be given to the use of concrete paths or other suitable surfaces in the scour protection to provide for the safe and effective passage of fauna.</li> </ul> | Construction contractor | Pre-construction |
| BI-17                      | Use of wildlife connectivity structures | <ul style="list-style-type: none"> <li>The alternative pre-cast concrete arch structure will be designed to incorporate a re-design of the rope crossing structure to traverse through the arch for the passage of fauna. In particular a further site assessment and survey of any outstanding remnant trees may be required to identify opportunities to link the rope structure to remnant forest and not isolated or immature trees.</li> </ul>  | Construction contractor | Pre-construction |
| BI-18                      | Vegetation and habitat removal          | <ul style="list-style-type: none"> <li>A landscape/revegetation management plan will be prepared to detail the requirements for revegetation, adjoining the retaining wall on both sides of the structure. Consideration will need to be given for weed management and site preparation prior to planting. Plant selection will need to consider local species appropriate for the low light conditions on the southern side of the road.</li> </ul>   | Construction contractor | Pre-construction |
| BI-19                      | Vegetation and habitat                  | <ul style="list-style-type: none"> <li>Natural vegetation will be retained where possible during construction, in particular any remnant trees adjacent to the road corridor.</li> </ul>   | Construction contractor | Construction     |
| <b>Aboriginal heritage</b> |   |  |                         |                  |
| AH-1                       | Impact to artefacts                     | <ul style="list-style-type: none"> <li>An application for an Aboriginal Heritage Impact Permit (AHIP) to 'harm' Site FB 1 and the surrounding area would be applied for prior to construction. In accordance with s90(3) of the <i>National Parks and Wildlife Act 1974</i> the RMS would need to apply for an 'area based' permit for the whole of the area proposed for the proposal.</li> </ul>   | RMS                     | Pre-construction |
| AH-2                       | Impact to artefacts                     | <ul style="list-style-type: none"> <li>The artefacts which are located in a container (on site) have been assessed as containing low significance. The container containing the artefacts was buried at a location outside of the proposal site. This site would be marked as no-go area on all relevant site plans, work instructions and fenced off on site.</li> </ul>  | RMS                     | Pre-construction |
| AH-3                       | Impact to artefacts                     | <ul style="list-style-type: none"> <li>The locations of the Aboriginal site GWH 36 would be marked as no-go area on all relevant site plans, work instructions and fenced off on site.</li> </ul>  | Construction contractor | Construction     |

| Ref #                          | Impact                                 | Environmental safeguards   | Responsibility                  | Timing                           |
|--------------------------------|--|--|---------------------------------|----------------------------------|
| AH-4                           | Unexpected artefacts                   | <ul style="list-style-type: none"> <li>In the event of an unexpected find of an Aboriginal heritage item (or suspected item), work would cease in the affected area and RMS's Environmental Officer, Western Region and the RMS Senior Environmental Specialist (Aboriginal heritage), would be contacted for advice on how to proceed.</li> <li>The <i>Draft Unexpected Finds Procedure</i> (RTA, 2011b) would be followed in the event of the uncovering of a potential item.</li> </ul>   | Construction contractor         | Construction                     |
| <b>Non-Aboriginal heritage</b> |  |  |                                 |                                  |
| NH-1                           | Unexpected heritage found              | <ul style="list-style-type: none"> <li>If an item (or suspected item) of non-Aboriginal heritage is discovered, RMS <i>Unexpected Finds Procedure</i> (RMS, 2012c) would be implemented including that all work in the area of the find would cease immediately and would not recommence until the heritage value and associated protection and any approval requirements have been determined. RMS would notify OEH if any item (or suspected item) of non-Aboriginal heritage is found during construction to determine the appropriate course of action.</li> </ul>   | RMS and construction contractor | Construction                     |
| NH-2                           | General impact to all heritage items   | <ul style="list-style-type: none"> <li>Mapping of exclusion zones and fencing of all areas requiring protection during the construction of the proposal would be undertaken prior to commencement of works. Maps would be included in the non-Aboriginal heritage sub-plan of the overall CEMP.</li> <li>The project induction would include details on the location and significance of heritage items and be provided to construction workers prior to commencement of construction works.</li> <li>Measures to minimise impacts from construction activities and truck movements and would be included in the non-Aboriginal heritage sub-plan of the overall CEMP.</li> <li>Management measures would be determined during detailed design to minimise impacts from construction compounds and increased traffic movements on all identified heritage items</li> </ul> | RMS and construction contractor | Detailed design and construction |
| NH-3                           | Impact to bridge/road party encampment | <ul style="list-style-type: none"> <li>Testing in northern areas would be undertaken prior to construction. Detailed archaeological recording and site interpretation would be undertaken if remains are found.</li> </ul>   | RMS                             | Detailed design                  |

| Ref # | Impact   | Environmental safeguards  | Responsibility          | Timing           |
|-------|--|---|-------------------------|------------------|
| NH-4  | Impact to bridge/road party encampment   | <ul style="list-style-type: none"> <li>Works would be undertaken in accordance with a Section 140 approval (obtained prior to commencement of construction).</li> </ul>   | Construction contractor | Construction     |
| NH-5  | Impact to Forty Bends Road, Mitchell's line of road and culverts                   | <ul style="list-style-type: none"> <li>A condition assessment survey of the pavement and culverts would be undertaken prior to the commencement of construction works. Key areas of this road, especially along the original or early sections of Forty Bends Road, would be avoided wherever possible.</li> </ul>  | RMS                     | Pre construction |
| NH-6  | Impact to old line of road and potential culverts associated with existing highway | <ul style="list-style-type: none"> <li>Archaeological monitoring of construction works in areas of potential culverts would be undertaken during construction. Reburying remains of earlier culverts with appropriate protection may be considered as works progress and would be undertaken in accordance with the RMS <i>Unexpected Finds Procedure</i> (RMS, 2012c).</li> <li>Works would be undertaken in accordance with a Section 140 approval (obtained prior to commencement of construction).</li> </ul> | Construction contractor | Construction     |
| NH-7  | Impact to Daintree Cottage   | <ul style="list-style-type: none"> <li>Consultation with Lithgow City Council would be undertaken during detailed design, to further avoid or minimise impacts including maintaining plantings where possible. In the event that the identified cedar trees cannot be retained through further refinement of the design, appropriate landscaping to mitigate the impacts on this item would be investigated in consultation with the property owner.</li> </ul>   | RMS                     | Detailed design  |
| NH-8  | Impact to Daintree Cottage   | <ul style="list-style-type: none"> <li>The strategies developed in consultation with Lithgow City Council would be implemented during construction.</li> </ul>  | Construction contractor | Construction     |
| NH-9  | Impact to Emoh (Emu Store/Corderoy's Store)  | <ul style="list-style-type: none"> <li>A building condition survey would be undertaken prior to commencement of works by a qualified contractor (in accordance with noise and vibration safeguard NV-17 – refer to section 6.4.5).</li> </ul>   | Construction contractor | Pre construction |
| NH-10 | Impact to Cottage 1960120  | <ul style="list-style-type: none"> <li>A building condition survey would be undertaken prior to commencement of works by a qualified contractor (in accordance with noise and vibration safeguard NV-17 – refer to section 6.4.5).</li> </ul>   | Construction contractor | Pre construction |
| NH-11 | Impact to unknown relics in compound areas   | <ul style="list-style-type: none"> <li>A survey of all proposed compound areas would be undertaken prior to construction to identify any constraints or areas to be avoided.</li> <li>Appropriate management strategies would be put in place to safeguard against any potential impacts to heritage items as a result of proposed compound and/or stockpile sites.</li> </ul>  | RMS                     | Pre construction |

| Ref #        | Impact   | Environmental safeguards  | Responsibility                                     | Timing                                      |
|--------------|--|---|--|---|
| NH-12        | Potential impacts to unidentified relics in water quality basins near Emoh and Cottage 1960116 | <ul style="list-style-type: none"> <li>Works would be undertaken in accordance with a Section 140 approval (obtained prior to commencement of construction) with respect to the location of the proposed sedimentation basin.</li> </ul>  | Construction contractor                            | Construction                                |
| <i>NH-13</i> | <i>Impact to Forty Bends Road, Mitchell's line of road and culvert</i>                         | <ul style="list-style-type: none"> <li><i>Detailed design must ensure that there will be no impact on Culvert 5 or the road during or after construction.</i></li> <li><i>A curtilage of about 5 metres distance between Culvert 5 and the footprint of the new arch/embankment must be maintained so as not to provide physical and visual dominance over Culvert 5 and the 1830's line of road.</i></li> <li><i>There should be no impact on Forty Bends Road by the new proposal, either its width, its cutting, and the culverts.</i></li> </ul>  | <i>Project manager<br/>Construction contractor</i> | <i>Detailed design and Pre-construction</i> |
| <i>NH-14</i> | <i>Impact to Forty Bends Road, Mitchell's line of road and culvert</i>                         | <ul style="list-style-type: none"> <li><i>Mitigation of impacts during construction will involve:</i> <ul style="list-style-type: none"> <li><i>Vibration management during construction.</i></li> <li><i>Fencing of areas where there should be no impact and to protect the culvert.</i></li> <li><i>Resolution of likely urban design issues in relation to this area so as to minimise the visual impact of the new proposal.</i></li> </ul> </li> <li><i>Planting of appropriate trees (to be identified in consultation with RMS biodiversity specialists as part of the detailed design of the revised proposal) to reduce visual impacts along this section of roadway, to maintain the 'country lane' aspect of this roadway.</i></li> </ul> | <i>Project manager<br/>Construction contractor</i> | <i>Construction</i>                         |

| Ref #                      | Impact                         | Environmental safeguards   | Responsibility          | Timing                |
|----------------------------|--------------------------------|--|-------------------------|-----------------------|
| <b>Noise and vibration</b> |                                |  |                         |                       |
| NV-1                       | General                        | <ul style="list-style-type: none"> <li>Prior to construction commencing, a Construction Noise and Vibration Management Plan (CNVMP) would be prepared. This document would detail how work is to be carried out to minimise the impact of noise and vibration from construction operations on adjacent properties.</li> </ul>  | Construction contractor | Prior to construction |
| NV-2                       | Noise affected residences      | <ul style="list-style-type: none"> <li>During the detailed design stage of the proposal, investigations of all feasible and reasonable mitigation treatments would be considered for the affected receivers during operation of the proposal.</li> </ul>   | RMS                     | Prior to construction |
| NV-3                       | Construction equipment impacts | <ul style="list-style-type: none"> <li>Construction equipment and methodology would also be assessed during detailed design and construction in regards to minimising impacts to heritage buildings.</li> </ul>  | Construction contractor | Prior to construction |
| NV-4                       | Out of hours work              | <ul style="list-style-type: none"> <li>Works would be carried out during standard working hours (ie 7 am–6 pm Monday to Friday, 8 am–1 pm Saturdays). Any work that is performed outside normal work hours or on a Sunday or public holiday is to minimise noise impacts in accordance with RMS's <i>Environmental Noise Management Manual</i> (RTA 2001), <i>Practice Note vii – Roadworks Outside of Normal Working Hours</i> and the <i>Interim Construction Noise Guidelines</i> (DECC 2009). This would include notifying the local community of any works planned to be undertaken outside standard construction hours.</li> </ul> | Construction contractor | Construction          |
| NV-5                       |                                | <ul style="list-style-type: none"> <li>Contact with the local community and those receivers potentially affected by the proposed works (outside of recommended construction hours) would be made prior to out of hours work and would include informing them by letter of the proposed work, location, type of work days and dates of work and hours involved. The contact would be made no less than 5 days prior to commencement of works.</li> </ul>  | Construction contractor | Construction          |
| NV-6                       |                                | <ul style="list-style-type: none"> <li>A suitable advertisement should be placed in local papers including a reference to night-time noise impacts.</li> </ul>   | Construction contractor | Construction          |

| Ref # | Impact  | Environmental safeguards   | Responsibility          | Timing       |
|-------|---|--|-------------------------|--------------|
| NV-7  | General noise mitigation measures during construction | <ul style="list-style-type: none"> <li>Equipment would be operated and maintained so that noise emissions are minimised. The selection of plant and equipment would be based on noise emission levels. This equipment would be operated and maintained so that noise emissions are minimised</li> </ul>        | Construction contractor | Construction |
| NV-8  |   | <ul style="list-style-type: none"> <li>Equipment and work sites would be orientated where possible to reduce noise emissions to sensitive receivers.</li> </ul>  | Construction contractor | Construction |
| NV-9  |   | <ul style="list-style-type: none"> <li>Where possible, using noisy plant simultaneously and/or close together would be avoided.</li> </ul>   | Construction contractor | Construction |
| NV-10 | General noise mitigation measures during construction | <ul style="list-style-type: none"> <li>The use of quieter construction methods where required and where considered reasonable and feasible. This may include grinding, rock splitting or terrain levelling instead of hydraulic rock breaking.</li> </ul>  | Construction contractor | Construction |
| NV-11 |   | <ul style="list-style-type: none"> <li>Where Work Health &amp; Safety issues can be safely managed, the use of alternatives to reversing alarms such as spotters, closed circuit television monitors and 'smart' reversing alarms, particularly during night time activities would be used on site.</li> </ul> | Construction contractor | Construction |
| NV-12 |   | <ul style="list-style-type: none"> <li>Machinery would not be turned on prior to the normal work hours. This would include the daily maintenance activities and/or 'warming up' of engines.</li> </ul>   | Construction contractor | Construction |
| NV-13 |   | <ul style="list-style-type: none"> <li>After community consultation, the use of temporary noise shielding would be implemented at locations where substantial exceedances of construction noise goals are predicted.</li> </ul>  | Construction contractor | Construction |
| NV-14 |   | <ul style="list-style-type: none"> <li>Concentrated noise sources, such as site compounds would be located as far as possible from sensitive receivers.</li> </ul>   | Construction contractor | Construction |
| NV-15 |   | <ul style="list-style-type: none"> <li>A Construction Traffic Management Plan would be developed for the proposal and where feasible and reasonable, haulage routes would be designed to minimise impacts on residential receivers (refer to section 6.7.4).</li> </ul>  | Construction contractor | Construction |

| Ref # | Impact  | Environmental safeguards  | Responsibility          | Timing       |
|-------|---|---|-------------------------|--------------|
| NV-16 | General vibration mitigation measures during construction | <ul style="list-style-type: none"> <li>Where hydraulic hammering or dynamic compaction is proposed within 50 metres of any structure (residential or commercial) or utility/service, a building condition survey would be conducted and preliminary vibration monitoring undertaken by a qualified contractor. Where pile driving is to be undertaken within 200 metres of a residential dwelling, additional surveys would be undertaken.</li> </ul> | Construction contractor | Construction |
| NV-17 |   | <ul style="list-style-type: none"> <li>Non building structures such as culverts and walls may not be adequately addressed by the building vibration criteria outlined in this report. Where these structures are identified, a condition assessment survey is required to assess and identify appropriate construction vibration levels and mitigation measures.</li> </ul>   | Construction contractor | Construction |
| NV-18 |   | <ul style="list-style-type: none"> <li>Appropriately sized equipment would be selected in order to minimise vibration emissions where required.</li> </ul>  | Construction contractor | Construction |
| NV-19 |   | <ul style="list-style-type: none"> <li>Vibratory compactors would be replaced with normal compactors where vibration issues have been identified, and it is considered feasible and reasonable.</li> </ul>  | Construction contractor | Construction |
| NV-20 | General vibration mitigation measures during construction | <ul style="list-style-type: none"> <li>A management procedure would be implemented in combination with a CNVMP to manage vibration complaints.</li> </ul>   | Construction contractor | Construction |
| NV-21 |   | <ul style="list-style-type: none"> <li>Vibration testing would be undertaken on high risk plant to determine site specific buffer distances.</li> </ul>   | Construction contractor | Construction |
| NV-22 |   | <ul style="list-style-type: none"> <li>Where vibration is found to exceed project criteria, management measures would be implemented to control vibration. In terms of human comfort criteria, measures would include modifications of construction methods and respite periods. For potential structural damage impacts, modification of construction methods would be necessary.</li> </ul>   | Construction contractor | Construction |

| Ref # | Impact   | Environmental safeguards   | Responsibility          | Timing       |
|-------|--|--|-------------------------|--------------|
| NV-23 |  | <ul style="list-style-type: none"> <li>• Building condition surveys for all buildings (including heritage buildings) and heritage culverts within 50 metres of the construction works would be prepared before and after construction in accordance with the CNVMP. Building condition surveys would also be undertaken at receivers with specified distances of certain construction activities and plant, as below:               <ul style="list-style-type: none"> <li>○ Driven piling – 200 metres.</li> <li>○ Vibratory compaction – 25 metres to 50 metres.</li> <li>○ Demolition works – 50 metres.</li> <li>○ Excavation works – 10 metres.</li> </ul> </li> </ul>  | Construction contractor | Construction |
| NV-24 | Noise complaints   | <ul style="list-style-type: none"> <li>• A community liaison phone number and permanent site contact would be provided so that complaints can be received and addressed in a timely manner.</li> <li>• Upon receipt of a noise complaint monitoring would be undertaken and reported as soon as possible. If exceedances are detected, the situation would be reviewed in order to identify means to attempt to reduce the impact to acceptable levels.</li> </ul>   | Construction contractor | Construction |
| NV-25 | Noise and vibration impacts to highly affected receivers | <ul style="list-style-type: none"> <li>• Highly noise affected receivers would require additional measures to minimise noise impacts which are likely to include consultation with residents, substitution of noisy plant, provision of temporary barriers, potential reduced hours of work and the provision of respite periods. Details of these considerations are as follows:               <ul style="list-style-type: none"> <li>○ Temporary relocations: Where short term works are predicted to have a significant impact upon a small number of receivers, temporary relocation of residents would form part of the measures considered for noise control. This would be considered during the detailed design and as required during construction in accordance with any onsite monitoring undertaken.</li> <li>○ Equipment selection: The selection of plant and equipment will have a significant bearing on the noise associated with construction activities. Where alternate plant is available, the plant emitting the lowest noise levels should be selected for use. Similarly, where an alternate method for undertaking a process or activity would result in reduced noise emissions, this should be considered where practicable.</li> </ul> </li> </ul> | Construction contractor | Construction |

| Ref #                | Impact                                  | Environmental safeguards  | Responsibility          | Timing          |
|----------------------|---|---|-------------------------|-----------------|
|                      |   | <ul style="list-style-type: none"> <li>○ Distance: Throughout each construction activity, stationary plant items should be located as far from receivers as practical.</li> <li>○ Screening: The erection of temporary hoarding/screens may prove to be suitable for some activities depending on location of works and proximity to residences.</li> <li>○ Enclosures: Enclosures can form a successful method for reducing noise at source, however enclosures are only suitable for certain types of plant. Enclosures do not work for plant items that are mobile, such as excavators, dozers etc.</li> <li>○ Engine silencers: Mobile plant and equipment should be chosen to include exhaust silencers or be suitable for fitting mufflers.</li> <li>○ Reversing alarms: Where acceptable safety standards can be met, alternatives to 'beeping' reversing alarms (such as spotters, closed circuit television monitors and 'smart' reversing alarms), particularly during night time activities, would be considered.</li> </ul> |                         |                 |
| <b>Water quality</b> |   |   |                         |                 |
| WQ-1                 | Erosion impacts during peak flow events | <ul style="list-style-type: none"> <li>● Water quality mitigation measures such as erosion control to minimise potential increases in suspended solid export rates during increased peak flow events would be considered at critical locations. These locations experiencing increased velocities will be identified by the detailed hydraulic assessment that will be undertaken during detailed design.</li> </ul>  | RMS                     | Detailed design |
| WQ-2                 | General impact mitigation measures      | <ul style="list-style-type: none"> <li>● A Soil and Water Management Plan (SWMP) would be developed prior to construction and implemented throughout the construction period of the proposal.</li> <li>● An Erosion and Sediment Control Plan (ESCP) would be developed prior to construction and implemented throughout the construction period of the proposal.</li> <li>● The extent and time of exposed soil would be minimised through construction sequencing.</li> <li>● The lengths of slopes would be minimised through limiting the extent of excavations to reduce water velocity over disturbed areas.</li> </ul>   | Construction contractor | Construction    |

| Ref # | Impact   | Environmental safeguards   | Responsibility          | Timing       |
|-------|--|--|-------------------------|--------------|
|       |  | <ul style="list-style-type: none"> <li>• Offsite runoff would be diverted around or through the site so that it would not mix with onsite construction runoff. This would be achieved by using temporary or permanent diversion drains to minimise the volume of flow through the construction area.</li> <li>• Physical controls in line with the ESCPs, including: sediment fences, sediment filters, rock check dams, level spreaders, onsite diversion drains would be installed prior to construction and maintained during construction.</li> <li>• Line channels and other concentrated flowpaths would be installed during construction.</li> <li>• Exposed soils would be revegetated as soon as possible.</li> <li>• Line exposed batters would be installed during construction, if required.</li> <li>• Runoff would be captured from exposed areas in sediment basins and would be treated to reduce sediment to the required level prior to discharging into downstream waterways.</li> <li>• A soil conservationist from the RMS Erosion, Sedimentation and Soil Conservation Consultancy Services Register would be engaged during detailed design to develop an Erosion and Sedimentation Management Report which would inform the SWMP.</li> </ul> |                         |              |
| WQ-3  | Increased levels of nutrients transported via sediment to downstream water courses   | <ul style="list-style-type: none"> <li>• Where feasible, grassed swales would be incorporated into the treatment train design to provide additional nutrient reduction.</li> </ul>   | Construction contractor | Construction |
| WQ-4  | Chemical, heavy metal, oil and grease and petroleum hydrocarbon spills from construction machinery directly polluting downstream waterways | <ul style="list-style-type: none"> <li>• Chemicals and other pollutants would be stored in a bunded or sealed area.</li> </ul>   | Construction contractor | Construction |

| Ref # | Impact   | Environmental safeguards  | Responsibility          | Timing       |
|-------|--|---|-------------------------|--------------|
| WQ-5  | Increased levels of litter from construction activities polluting downstream watercourses  | <ul style="list-style-type: none"> <li>Litter would be managed on site by construction team.</li> <li>Sediment basin would be designed to include trash racks to collect litter prior to entering basins. Regular maintenance of trash racks would be undertaken.</li> </ul>                                | Construction contractor | Construction |
| WQ-6  | Increased levels of sediments, chemicals, nutrients, heavy metals, oils, grease, litter and other pollutants flowing to the Sydney's drinking water supply catchment   | <ul style="list-style-type: none"> <li>Safeguards as per WQ-1 and WQ-2.</li> <li>Increase the design requirements of the sediment basins from the eightieth percentile five day rainfall value would be adopted in accordance with the Blue Book, to the eighty-fifth percentile rainfall value.</li> </ul> | Construction contractor | Construction |
| WQ-7  | Moderate levels of soil erodibility increasing the likelihood and severity of sediment erosion during rainfall events  | <ul style="list-style-type: none"> <li>Safeguards as per WQ-1 and WQ-2.</li> </ul>  | Construction contractor | Construction |
| WQ-8  | Temporary diversions of waterways, the construction of permanent waterway diversions and the construction of in-stream structures in waterways disturbing the bed and banks of the waterway, causing soil and streambank erosion | <ul style="list-style-type: none"> <li>Construction would be in line with RMS's <i>Technical Guideline - Temporary Stormwater Drainage for Main Road Construction</i> (2011).</li> </ul>  | Construction contractor | Construction |

| Ref # | Impact  | Environmental safeguards   | Responsibility          | Timing       |
|-------|---|--|-------------------------|--------------|
| WQ-9  | Construction of large excavations and embankments causing an elevated risk to water quality in downstream waterways through the increased likelihood of movement of sediment off steep slopes   | <ul style="list-style-type: none"> <li>• Safeguards as per WQ-1.</li> <li>• Revegetation of exposed batters would occur as soon as possible.</li> </ul>  | Construction contractor | Construction |
| WQ-10 | Construction in acid sulfate soils (ASS) disturbing and exposing ASS to oxygen, resulting in the generation of sulphuric acid and toxic quantities of aluminium and other heavy metals. These could be released into the surrounding environment, causing acidification of receiving surface waters and groundwater | <ul style="list-style-type: none"> <li>• ASS would be managed in accordance with the relevant guidelines.</li> <li>• The SWMP would include an ASS Management Sub Plan</li> <li>• Should ASS be detected where excavation is required, works would proceed according to the sub plan and would involve: <ul style="list-style-type: none"> <li>○ Capping of exposed surfaces with clean fill to prevent oxidation.</li> <li>○ Place excavated ASS separately in a lined, bunded and covered area.</li> <li>○ Neutralising ASS for reuse by using soil additives such as lime.</li> <li>○ Disposal of ASS where necessary in accordance with the relevant guidelines.</li> </ul> </li> <li>• The management of ASS during construction that may impact on the acidity of the receiving waterways would be described in the Geotechnical Technical Paper.</li> </ul> | Construction contractor | Construction |
| WQ-11 | Stockpiling of earthworks causing a risk to downstream water quality during rainfall event, through transport of large amounts of sediments from the stockpiles into waterways  | <ul style="list-style-type: none"> <li>• Stockpile sites would be included in the ESCP and safeguards.</li> <li>• The maintenance of established stockpile sites during construction would be in accordance with the RMS <i>Stockpile Site Management Procedures</i> (2001).</li> <li>• Stockpile locations would be away from overland flowpaths and areas of high topography with minimal upstream catchment.</li> <li>• Runoff would be directed around stockpiles sites.</li> <li>• The number and size of stockpiles would be minimised throughout the proposal site.</li> <li>• The base of stockpiles would be lined if they are located over a shallow water table.</li> </ul>   | Construction contractor | Construction |

| Ref # | Impact   | Environmental safeguards  | Responsibility          | Timing       |
|-------|--|---|-------------------------|--------------|
|       |  | <ul style="list-style-type: none"> <li>• Stockpiles would be covered with plastic sheets, where required.</li> <li>• If uncovered, runoff from stockpile sites would be treated with a stockpile-specific sediment basin and monitoring the sediment basin for parameters such as dissolved oxygen levels and organics to determine suitable discharge to the environment.</li> </ul>   |                         |              |
| WQ-12 | Stockpiling vegetation from cutting of trees and slashing of shrubs causing a risk of tannins leaching into waterways and increased loads of organics in waterways | <ul style="list-style-type: none"> <li>• Mitigation of tannins leaching from mulch stockpiles into waterways would be in line with RMS's <i>Environmental Direction - Management of Tannins from Vegetation Mulch</i> (2012).</li> </ul>  | Construction contractor | Construction |
| WQ-13 | Storage of chemicals causing a risk of contaminated spills into downstream waterways   | <ul style="list-style-type: none"> <li>• Management of site compound runoff would be included in the ESCP.</li> <li>• Plant would be located within a bunded area, preferably away from overland flowpath and in areas of high topography with minimal upstream catchment.</li> <li>• Chemicals would be stored within a sealed or bunded area.</li> <li>• Line the base of plant areas if they are located over a shallow water table.</li> <li>• Treat runoff from site compound with a site specific sediment basin to the required level prior to discharging into downstream waterways.</li> </ul> | Construction contractor | Construction |
| WQ-14 | Vehicle washdown areas causing a risk of contaminated spills into downstream waterways   | <ul style="list-style-type: none"> <li>• Safeguards as per WQ-12.</li> </ul>  | Construction contractor | Construction |
| WQ-15 | Vehicle refuelling areas causing a risk of contaminated spills into downstream waterways   | <ul style="list-style-type: none"> <li>• Safeguards as per WQ-12.</li> </ul>  | Construction contractor | Construction |

| Ref # | Impact   | Environmental safeguards   | Responsibility          | Timing          |
|-------|--|--|-------------------------|-----------------|
| WQ-16 | High frequency of vehicle movements disturbing soils and causing sediment loads to be washed into downstream waterways   | <ul style="list-style-type: none"> <li>• Safeguards as per WQ-1 and WQ-2</li> <li>• Site compound would include placement away from overland flowpaths and in flat areas of high topography with minimal upstream catchment.</li> <li>• Restrict vehicle movements to designated pathways where feasible.</li> <li>• Areas that would be exposed for extended periods, such as carparks and main access roads, would be paved where feasible.</li> </ul> | Construction contractor | Construction    |
| WQ-17 | Surface runoff from impervious areas and landscaped batters during the establishment period transporting suspended sediments to surrounding watercourses or infiltrate into the groundwater system                 | <ul style="list-style-type: none"> <li>• The SWMP would include operational water management controls and an associated maintenance and inspection program.</li> <li>• A physical treatment train that includes elements such grassed swales, biofiltration swales and water quality would be developed to ensure total suspended solids are reduced by at least 80 per cent prior to discharging into downstream waterways.</li> </ul>                  | Construction contractor | Detailed design |
| WQ-18 | Surface runoff from impervious areas transporting contaminants such as heavy metals, oil, grease, chemicals and litter attached to particles to surrounding watercourses or infiltrate into the groundwater system | <ul style="list-style-type: none"> <li>• Mitigation measures as per WQ-16.</li> <li>• Treatment train designed to ensure no oil or grease is visible when discharging into downstream waterways.</li> </ul>  | Construction contractor | Detailed Design |

| Ref # | Impact   | Environmental safeguards  | Responsibility          | Timing                        |
|-------|--|---|-------------------------|-------------------------------|
| WQ-19 | Surface runoff from impervious surfaces transporting nutrients such as nitrogen and phosphorus to surrounding watercourses or infiltrate into the groundwater system | <ul style="list-style-type: none"> <li>Mitigation measures as per WQ-16.</li> <li>Treatment train to provide at least 45% reduction of total nitrogen and 45% reduction of total phosphorus.</li> </ul>   | Construction contractor | Detailed design and operation |
| WQ-20 | Concentration of runoff by drains and kerbs causing scour  | <ul style="list-style-type: none"> <li>Outlet structures such as culverts and basin spillways would incorporate lining to avoid scour downstream of the outlet or spillway.</li> <li>Open drains and channels would be lined with appropriate material to prevent scour as part of the drainage design.</li> </ul>  | Construction contractor | Operation                     |
| WQ-21 | Erosion through the introduction of additional permanent physical obstructions in waterways, such as bridge piers  | <ul style="list-style-type: none"> <li>Waterways around any such additional permanent structures would be lined appropriately to avoid erosion</li> </ul>   | Construction contractor | Operation                     |
| WQ-22 | Maintenance practices such as herbicide use, mowing, road surface cleaning and reparation polluting downstream waterways   | <ul style="list-style-type: none"> <li>RMS standard maintenance controls would be applied in a manner that would minimise any potential water pollution.</li> </ul>   | Construction contractor | Operation                     |
| WQ-23 | Accidental spillage of hazardous materials, could passing rapidly into the drainage system and impacting downstream ecosystems                                       | <ul style="list-style-type: none"> <li>Water quality ponds would incorporate accidental spill management containment of spills up to 40,000L through an appropriate baffle arrangement with an underflow or 'Ellis' pipes at the outlet end of the pond.</li> <li>Where water quality ponds are not part of the highway drainage system dedicated spill retention would be required.</li> </ul> | Construction contractor | Operation                     |

| Ref #            | Impact  | Environmental safeguards   | Responsibility                 | Timing                          |
|------------------|---|--|--------------------------------|---------------------------------|
| <b>Hydrology</b> |   |  |                                |                                 |
| HY-1             | Dams directly affected by the proposal  | <ul style="list-style-type: none"> <li>RMS would liaise with affected property owners regarding strategies to mitigate the loss of any farm dams.</li> </ul>   | RMS                            | Detailed design                 |
| HY-2             | Potential blockages, diversions or erosion of waterways or drainage lines                         | <ul style="list-style-type: none"> <li>Drainage structures would be designed to convey flows under the proposal.</li> <li>Appropriate scour protection measures would be implemented at Whites Creek bridge and drainage structures during construction.</li> </ul>  | RMS<br>Construction contractor | Detailed design<br>Construction |
| HY-3             | Potential changes in the yield to affected farm dams resulting from the operation of the proposal | <ul style="list-style-type: none"> <li>Consultation with affected landowners would be undertaken to confirm the current use of affected farm dams and to evaluate the effect of the impact of peak flow/volumes (e.g. reduced amenity, increased maintenance etc).</li> <li>Communication of these impacts to the landowner would highlight the acceptability of the impact and identify the requirement for additional mitigation measures.</li> <li>Where landowners are concerned regarding the potential impacts, mitigation measures that would be considered for further investigation could include: <ul style="list-style-type: none"> <li>Reduction of impacts through additional investigation of detailed design of the cross drainage/longitudinal drainage system for the proposal.</li> <li>Mitigation of increased peak flow impacts through the provision of detention storage within the proposed water quality treatment structures (ie basins).</li> <li>Mitigation of increased flow volumes/peak flow impacts through energy dissipation design and channel linings at the affected farm dams/drainage line, subject to the agreement of the affected landowner.</li> <li>Mitigation of decreased flow volumes to farm dams by enlarging existing farm dams to increase available storage capacity, subject to agreement with the affected landowner.</li> <li>A detailed assessment of the potential changes in yield to farms dams would be undertaken during the detailed design to confirm the level of impact.</li> <li>Hold discussions with affected landowners regarding suitable mitigation measures as required.</li> </ul> </li> </ul> | RMS                            | Detailed design                 |

| Ref #                | Impact  | Environmental safeguards  | Responsibility           | Timing           |
|----------------------|---|---|--------------------------|------------------|
| HY-4                 | Increased extreme rainfall events due to climate change increasing afflux   | <ul style="list-style-type: none"> <li>As necessary, further flood modelling assessment of potential climate change impacts would be undertaken during the detailed design in consultation.</li> </ul>  | RMS                      | Detailed design  |
| HY-5                 | Flooding caused by blockages to flood paths during construction   | <ul style="list-style-type: none"> <li>Flood flow paths would be maintained during construction activities at Whites Creek.</li> <li>Diversion bunds would be used to divert flows around construction works.</li> </ul>  | Contractor               | Construction     |
| <b>Geomorphology</b> |   |   |                          |                  |
| GM-1                 | Potential for geomorphological impacts resulting from increased flows into the tributary of Whites Creek that flows from the north west | <ul style="list-style-type: none"> <li>A geomorphological site investigation survey would be undertaken for the 1250 metre long tributary of Whites Creek immediately to the west of the proposed bridge.</li> <li>If required, measures would be incorporated into the detailed design to prevent or mitigate erosion along the tributary.</li> </ul>  | Geomorphology specialist | Pre-construction |
| <b>Geology</b>       |   |   |                          |                  |
| GE-1                 | Geotechnical  | <ul style="list-style-type: none"> <li>Measures to minimise the impact of landslip and rockfalls during the construction and operation of the proposal would be determined during detailed design.</li> </ul>   | RMS                      | Detailed design  |
| GE-2                 | Acid sulphate rock  | <ul style="list-style-type: none"> <li>Further testing would be undertaken to quantify the likelihood that cuttings won from excavations and the potential that this would generate acid leachate. If present, ASR would be managed in accordance with the RTA (2005) <i>Guidelines for the Management of Acid Sulfate Materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze</i>.</li> </ul> | RMS                      | Construction     |

| Ref #                               | Impact  | Environmental safeguards  | Responsibility | Timing          |
|-------------------------------------|---|---|----------------|-----------------|
| <b>Urban design and landscaping</b> |   |   |                |                 |
| UD-1                                | General   | <ul style="list-style-type: none"> <li>Implementation of the landscape and urban design strategy would occur as part of the proposal as described in section 6.7 of this REF and Section 4 of Technical Paper 7 Landscape Character and Visual Impact Assessment.</li> </ul>  | RMS            | Detailed Design |
| UD-2                                | Vegetation clearing                                   | <ul style="list-style-type: none"> <li>Existing roadside trees would be retained wherever possible.</li> <li>Revegetation would be undertaken based on existing vegetation communities in medians and roadside areas.</li> <li>Safety barriers would be used where trees are located within clear zones to retain the maximum numbers of trees.</li> <li>Plants that are of non frangible species would be planted in the median to break up the expanse of hard surface.</li> <li>Openings would be provided in plantings at selected locations to take advantage of the significant long distance views to the south.</li> <li>Revegetation, based on existing vegetation communities (including grasses, groundcovers, shrubs, riparian species, and trees depending on sight line requirements), in medians and roadside areas would be undertaken to help to reduce perceived corridor width.</li> </ul> | RMS            | Construction    |
| UD-3                                | Visual impact of earthworks: embankments and cuttings | <ul style="list-style-type: none"> <li>Existing embankments would be retained wherever possible.</li> <li>Revegetate cut/fill batters would be undertaken with local species of trees, shrubs and groundcovers.</li> <li>Visually recessive materials, textures and colours would be used for retaining walls to reduce their visual dominance and blend with the unique landscape of this area.</li> <li>Screen planting would be used to reduce the visual dominance of retaining walls.</li> <li>The redundant road pavement would be removed and revegetated.</li> </ul>  | RMS            | Detailed Design |

| Ref # | Impact   | Environmental safeguards  | Responsibility          | Timing          |
|-------|--|---|-------------------------|-----------------|
| UD-4  | Visual impact of intersections and access arrangements | <ul style="list-style-type: none"> <li>Planting in verges, medians and traffic islands would be undertaken to soften and break up large areas of pavement and reduce perceived intersection width and screen visually unattractive infrastructure.</li> <li>Any ameliorative measures would consider sight distance restrictions.</li> </ul>  | RMS                     | Construction    |
| UD-5  | Visual impact of Whites Creek bridge                   | <ul style="list-style-type: none"> <li>Minimise depth of structure to reduce the visual impact of the bridge from surrounding areas as well as minimise impact to the creek bed, banks and vegetation.</li> <li>Minimise number of bridge piers would be kept to a minimum so as to keep views through and across the bridge as open as possible.</li> <li>Tapering of the bridge piers would be considered during detailed design.</li> <li>Screen the construction compound with local tree species.</li> </ul> | RMS                     | Detailed Design |
| UD-6  | Visual impact of culvert structures                    | <ul style="list-style-type: none"> <li>Culverts would be designed to be visually recessive by using dark coloured concrete on the wing walls and head wall and splaying the wing walls.</li> <li>Boulders would be stacked in front of culverts to integrate the culverts into the surrounding bush environment.</li> <li>Dark coloured rock would be used for scour protection and place in a naturalistic way to disguise or replace the concrete pad.</li> </ul>   | RMS                     | Detailed Design |
| UD-7  | Impacts during construction                            | <ul style="list-style-type: none"> <li>The proposed construction compounds would be screened with temporary mesh fencing.</li> <li>The size of stockpile sites would be minimised wherever possible to reduce the visual impact of these sites.</li> <li>The surrounds of sedimentation basins would include plantings to provide a natural aesthetic.</li> </ul>   | Construction contractor | Construction    |

| Ref # | Impact   | Environmental safeguards   | Responsibility                 | Timing           |
|-------|--|--|--------------------------------|------------------|
| UD-8  | Visual impact of earth embankments and alternative bridge design | <ul style="list-style-type: none"> <li>• Design of the revised proposal must have an integrated engineering, urban design and biodiversity outcome.</li> <li>• Design must minimise the visual impact of hard elements associated with the size and extent of the retaining wall, earth embankment and culvert structure. The design of the revised proposed will address the following: <ul style="list-style-type: none"> <li>○ Consider sloping the underpass portal opening to match the gradient of the slope and revegetate the surrounding embankment.</li> <li>○ Consider reducing the height and scale of the reinforced earth walls by terracing, and/or changing the angle of the wingwall. The implementation of this measure may be dependent on liaison with adjoining landowners.</li> <li>○ Detailed design must integrate the earth embankments into the adjoining landform to minimise their visual appearance.</li> <li>○ Providing revegetation to the new embankments to visually integrate them with the heavily vegetated slopes of Hassans Walls.</li> <li>○ Protect the primary root zones of existing roadside trees outside of the proposal footprint, particularly those along Forty Bends Road.</li> <li>○ Continue shrub and groundcover planting to the median over the proposed pre-cast concrete arch and embankment structure to reduce the extent of hard surface and to help reduce perceived corridor width.</li> <li>○ Visually recessive materials, textures and colours, such as black oxide or pre-cast concrete panels with exposed basalt aggregate finish to the reinforced earth walls and pre-cast concrete arch structure (refer to Figure 4.1 in Appendix D).</li> <li>○ Place large boulders in a random formation in front of the foundations (whilst considering the ecological requirements outlined in BI-16) to reduce scour, using rock excavated from the site, otherwise use a grey basalt rock.</li> </ul> </li> </ul> | RMS<br>Construction contractor | Pre-construction |

| Ref #                        | Impact  | Environmental safeguards   | Responsibility          | Timing                               |
|------------------------------|---------|--|-------------------------|--------------------------------------|
| <b>Traffic and transport</b> |         |  |                         |                                      |
| TR-1                         | General | <ul style="list-style-type: none"> <li>• A construction traffic management plan (CTMP) would be prepared as part of the pre-construction planning. The plan would detail how the traffic associated with the construction would be managed in accordance with the RMS <i>Traffic Control at Work Sites</i> (RTA 2010), as well as relevant Australian Standards including AS1742 and the work site manual <i>RMS Specification G10</i>.</li> <li>• The CTMP would also be used to develop site-specific traffic management measures once the construction methods and haulage routes are finalised. These measures would be developed as part of the site-specific traffic management plans to indicate how traffic would be controlled and managed during each stage of the construction.</li> <li>• A vehicle movement plan (VMP) would be prepared as part of the overall CTMP. The VMP would assess construction related heavy vehicle movements per shift in to and out of the construction site/s. The VMP would identify elements of the construction such as: <ul style="list-style-type: none"> <li>○ Limiting the number of points where new alignments cross the existing road network.</li> <li>○ Limiting the need to occupy areas of the existing road.</li> <li>○ Identifying haulage routes for construction traffic including limiting the size of vehicles on Forty Bends Road due to curves and heritage culverts.</li> </ul> </li> <li>• Undertaking road condition surveys of local roads prior to construction.</li> </ul> | Construction contractor | Detailed design and pre-construction |

| Ref # | Impact  | Environmental safeguards   | Responsibility          | Timing                               |
|-------|---|--|-------------------------|--------------------------------------|
| TR-2  | Individual construction worksites                                   | <p>At the individual construction worksites, the following guiding principles would be adopted to manage traffic impacts:</p> <ul style="list-style-type: none"> <li>• Construction planning would occur through the use of construction staging and temporary road works to minimise interaction with the existing road network and night time freight vehicle movements.</li> <li>• The road space occupied by works and the time of construction would be minimised.</li> <li>• The impacts of construction works on local and regional traffic by using the new carriageway, would be minimised as far as practical.</li> <li>• Traffic control measures would be implemented only when necessary.</li> <li>• Property access would be maintained for the duration of the construction and where reasonable and feasible, alternative access would be provided in consultation with affected landowners.</li> <li>• Where possible, the site access points would incorporate a deceleration bay.</li> <li>• Monitoring of weather conditions would be undertaken in addition to inspection of roads during fog, ice and snow conditions during the winter months. Any impacts to safety including driver sight distance and road pavement conditions would be identified.</li> </ul> | Construction contractor | Pre-construction and construction    |
| TR-3  | Changes to access arrangements for emergency vehicles               | <ul style="list-style-type: none"> <li>• Consultation with emergency service authorities would be undertaken during development of the detailed design.</li> </ul>   | RMS                     | Detailed design and pre-construction |
| TR-4  | Buses prevented from informally stopping along the upgraded highway | <ul style="list-style-type: none"> <li>• A bus stop at the u-turn facility on McKanes Falls Road would be provided as part of the detailed design.</li> <li>• Consultation with local bus operators would be undertaken during development of the detailed design.</li> </ul>  | RMS                     | Detailed design                      |

| Ref # | Impact                    | Environmental safeguards  | Responsibility          | Timing       |
|-------|---------------------------|---|-------------------------|--------------|
| TR-5  | Coordinating works        | <p>Co-ordination of construction works would be undertaken to limit excessive delays. This would be achieved through:</p> <ul style="list-style-type: none"> <li>• Static signage and portable variable message signs (VMS) would be positioned to provide necessary proposal information, guidance and warning to motorists that drive through, past or adjacent to the proposal area.</li> <li>• Coordination of the delivery of construction materials and the movement of construction plant and equipment to and from construction sites.</li> <li>• Consideration of any cumulative traffic impacts from nearby development and to ensure coordination of works and construction traffic movements.</li> <li>• Coordination of all RMS works and any works by other agencies that affect traffic flow.</li> <li>• Coordination with transport operators regarding schedules, abnormal loads and other events.</li> <li>• Identification, evaluating and documentation of alternative routes (in consultation with local councils).</li> <li>• Coordination with emergency services and managing incidents.</li> </ul> | Construction contractor | Construction |
| TR-6  | Over dimensional vehicles | <p>Vehicles which are over-height, oversize or over-mass are subject to special operating conditions. Operators of trucking contractors would be required to apply for the necessary permits and a review of information including vehicle route maps, route assessment guidelines, travel restrictions and curfew times. The need for pilot vehicles and police escort vehicles would also need to be assessed as part of the CTMP.</p>  | Construction contractor | Construction |
| TR-7  | Community consultation    | <ul style="list-style-type: none"> <li>• The community would be kept informed regarding any potential disruptions to existing traffic conditions throughout the construction of the proposal.</li> </ul> <p>Disruption to property access would be notified the relevant property owner in advance of the disruption in accordance with the relevant community consultation processes outlined in the CTMP and CEMP.</p>  | Construction contractor | Construction |

| Ref #                        | Impact                                      | Environmental safeguards   | Responsibility | Timing           |
|------------------------------|---|--|----------------|------------------|
| TR-8                         | Black ice mitigation                        | <ul style="list-style-type: none"> <li>Where safety barriers are required, utilise wire rope barriers between carriageways together with road grading to prevent pooling of cold air.</li> <li>Development of an active winter black ice maintenance program.</li> <li>Installation of a weather station to obtain local meteorological data.</li> <li>Ice warning signage.</li> </ul>   | RMS            | Operation        |
| <b>Land use and property</b> |   |  |                |                  |
| LU-1                         | General impacts to properties               | <ul style="list-style-type: none"> <li>Impacts to property would be further minimised during detailed design.</li> </ul>   | RMS            | Detailed design  |
| LU-2                         | Change in property access                   | <ul style="list-style-type: none"> <li>Consultation and communication would be undertaken with property owners near the proposal about changes to property access and local access to the highway during operation.</li> </ul>   | RMS            | Detailed design  |
| LU-3                         | Property acquisition                        | <ul style="list-style-type: none"> <li>Ongoing consultation and communication with directly affected property owners about potential property acquisition. This includes the provision of information on the timing of acquisition and the process for property acquisition.</li> <li>Property acquisition would be managed in accordance with the <i>Land Acquisition (Just Terms Compensation) Act 1991</i> and the RMS's Land Acquisition Policy (RMS, 2012b).</li> </ul> | RMS            | Pre-construction |
| LU-4                         | Property access during construction         | <ul style="list-style-type: none"> <li>Ensure access to properties is maintained during construction. Where temporary property access is required, consultation would be undertaken with affected property owners to identify suitable alternate access arrangements.</li> </ul>   | Contractor     | Construction     |
| LU-3LU-5                     | Ongoing use of temporary construction sites | <ul style="list-style-type: none"> <li>On completion of construction activities, land used for the temporary construction site, stockpiles and drainage sumps/basins would be revegetated and left in a stable condition. Where these properties have been leased by RMS, these properties would be returned to the original landowners following rehabilitation of the site(s).</li> </ul>  | RMS            | Operation        |

| Ref #                 | Impact                                       | Environmental safeguards  | Responsibility          | Timing                     |
|-----------------------|--|---|-------------------------|----------------------------|
| <b>Socio-economic</b> |  |   |                         |                            |
| SE-1                  | Property impacts                             | <ul style="list-style-type: none"> <li>Ongoing communication and consultation would be undertaken with directly affected property owners about the property acquisition process. This would include the provision of information on the timing of acquisitions and the process for property acquisitions under the <i>Land Acquisition (Just Terms Compensation) Act 1991</i> and RMS's <i>Land Acquisition Policy</i> (RMS, 2012b).</li> </ul>   | RMS                     | Pre-construction           |
| SE-2                  | Changes in local access and traffic movement | <ul style="list-style-type: none"> <li>It would be ensured that changes to local access are clearly communicated to residents and other road users, including use of appropriate signage.</li> <li>Local road closures would be minimised as far as practical.</li> <li>Early and ongoing communication and consultation would be undertaken with emergency services to allow planning for potential changes to response patterns and input into the design development and staging, wherever practical.</li> <li>Residents would be advised of construction vehicle traffic routes and the likely timing of any disruptions.</li> <li>Where possible, transportation of materials for the proposal would be undertaken outside of peak traffic times.</li> </ul> | Construction contractor | Construction and operation |
| SE-3                  | Disruption to property access                | <ul style="list-style-type: none"> <li>Develop and implement traffic management plans to assist in minimising traffic disruptions and delays.</li> <li>Access to properties near the proposal would be maintained during construction, including, where required, maintaining provisions for the movement of farm equipment and livestock between properties.</li> <li>Where temporary changes to property access are required during construction, alternate access would be determined in consultation with affected property owners and tenants.</li> </ul>  | Construction contractor | Construction               |
| SE-4                  | Amenity                                      | <ul style="list-style-type: none"> <li>Early and ongoing consultation and communication would be undertaken with residents and local communities closest to construction works about construction activities, including timing, duration and likely impacts in particular where works are proposed outside of standard daytime construction hours.</li> </ul>   | Construction contractor | Construction               |

| Ref #              | Impact                    | Environmental safeguards   | Responsibility                  | Timing  |
|--------------------|---------------------------|--|---------------------------------|---|
| SE-5               | Economic impacts          | <ul style="list-style-type: none"> <li>Construction materials and other products and services would be locally sourced, as far as practicable.</li> </ul>  | Construction contractor         | Construction  |
| SE-6               | Roadside memorials        | <ul style="list-style-type: none"> <li>Prior to construction, the roadside memorial(s) that would be required to be relocated or removed as a result of the proposed would have a suitable alternative location identified in consultation with relatives, where they are able to be readily contacted.</li> </ul>   | RMS/<br>Construction contractor | Construction  |
| SE-7               | Amenity                   | <ul style="list-style-type: none"> <li>Where required, noise attenuation measures would be established to reduce traffic noise for at nearby properties.</li> <li>Where required, landscape screening would be provided for residents and communities near to the highway, to reduce the visual impacts of the proposal.</li> </ul>  | RMS/<br>Construction contractor | Operation   |
| <b>Air quality</b> |                           |  |                                 |   |
| AQ-1               | Construction Dust Impacts | <p>Control measures would be included in the CEMP to ensure that dust emissions are suitably managed such that air quality impacts at nearby sensitive receptors are minimised including:</p> <ul style="list-style-type: none"> <li>All materials transported to and from the construction site would be covered.</li> <li>Stockpiles of soil or other materials would be managed by the construction contractor to minimise dust emissions, particularly during dry or windy conditions.</li> <li>Speed limits would be imposed for equipment on unsealed surfaces.</li> <li>Stockpiles would be located as far away from residences as practically possible.</li> <li>The extent of disturbed areas would be minimised as far as practicable. This would be achieved by staging the works to minimise the number of disturbed areas at any one time.</li> <li>Disturbed areas would be rehabilitated as quickly as possible.</li> <li>Dust on unsealed surfaces, temporary roadways, stockpiles and other exposed areas would be suppressed using water trucks, hand held hoses, temporary vegetation and other practices.</li> <li>Activities resulting in excessive dust generation would be stopped or modified during very windy conditions.</li> </ul> | Construction Contractor         | <p>Pre-construction</p> <p>Construction</p> <p>Construction</p> <p>Construction</p> <p>Construction</p> <p>Construction</p> <p>Construction</p> |

| Ref #                                    | Impact   | Environmental safeguards  | Responsibility          | Timing          |
|--|--|---|-------------------------|-----------------|
|  |  | <ul style="list-style-type: none"> <li>Air quality, both visually and/or using instrumentation would be monitored near sensitive receptors to verify the effectiveness of controls.</li> <li>A wheel wash facility would be installed at compound and stockpile sites to reduce tracking of mud and soil off-site.</li> </ul> |                         | Construction    |
| AQ-2                                     | Construction Vehicle Emission Impacts  | <ul style="list-style-type: none"> <li>Operating and maintaining vehicles and equipment would occur in accordance with manufacturer's specifications.</li> </ul>  | Construction Contractor | Construction    |
| <b>Greenhouse gas and climate change</b> |  |   |                         |                 |
| GG-1                                     | Operational GHG impacts from vehicle emissions   | <ul style="list-style-type: none"> <li>The route length and road grade would be minimised to reduce the distance for traffic required and the effort required to climb steep grades.</li> </ul>   | RMS via road design     | Detailed design |
| GG-2                                     |  | <ul style="list-style-type: none"> <li>Measures would be adopted to avoid traffic congestion through staging during detailed design.</li> </ul>   | RMS via road design     | Detailed design |
| GG-3                                     | GHG emissions from fuel consumption and loss of carbon sink                            | <ul style="list-style-type: none"> <li>Vegetation clearance would be minimised, in particular native or replanted bush land. Where vegetation clearance is unavoidable, consideration should be given to replanting native species wherever possible.</li> </ul>  | Construction Contractor | Construction    |
| GG-4                                     | GHG emissions from fuel consumption and from embodied energy in construction materials | <ul style="list-style-type: none"> <li>Waste, in particular greenhouse gas waste would be minimised wherever possible.</li> </ul>   | Construction Contractor | Construction    |
| GG-5                                     | GHG emissions from loss of carbon sink   | <ul style="list-style-type: none"> <li>Cleared vegetation would be mulched for re-use on-site where feasible.</li> </ul>  | Construction Contractor | Construction    |
| GG-6                                     | GHG emissions from fuel consumption  | <ul style="list-style-type: none"> <li>Waste would be disposed of at local landfills rather than further afield wherever possible to avoid unnecessary transport emissions.</li> </ul>  | Construction Contractor | Construction    |
| GG-7                                     | GHG emissions from fuel consumption  | <ul style="list-style-type: none"> <li>Local suppliers for construction materials would be used wherever possible to avoid unnecessary transport emissions.</li> </ul>  | Construction Contractor | Construction    |
| GG-8                                     | GHG emissions from fuel consumption  | <ul style="list-style-type: none"> <li>Local staff would be utilised wherever possible to avoid unnecessary transport emissions.</li> </ul>   | Construction Contractor | Construction    |
| GG-9                                     | GHG emissions from fuel consumption  | <ul style="list-style-type: none"> <li>Fuel-efficient equipment would be selected wherever possible.</li> </ul>   | Construction Contractor | Construction    |

| Ref # | Impact   | Environmental safeguards  | Responsibility          | Timing       |
|-------|--|---|-------------------------|--------------|
| GG-10 | GHG emissions from fuel consumption                | <ul style="list-style-type: none"> <li>Biofuels (biodiesel, ethanol, or blends such as E10 or B80) would be considered wherever possible and available.</li> </ul>  | Construction Contractor | Construction |
| GG-11 | GHG emissions from fuel consumption                | <ul style="list-style-type: none"> <li>Plant and equipment would be regularly maintained to ensure maximum fuel efficiencies.</li> </ul>  | Construction Contractor | Construction |
| GG-12 | GHG emissions from fuel consumption                | <ul style="list-style-type: none"> <li>Energy-efficient work practices would be promoted on site, such as turning machinery off when not in use.</li> </ul>   | Construction Contractor | Construction |
| GG-13 | GHG emissions from fuel consumption                | <ul style="list-style-type: none"> <li>Energy-efficient lighting would be utilised (where available) during night works (if required).</li> </ul>   | Construction Contractor | Construction |
| GG-14 | GHG emissions from fuel consumption                | <ul style="list-style-type: none"> <li>Monitoring, recording and reporting energy consumption would be undertaken to identify and address energy wastage.</li> </ul>  | Construction Contractor | Construction |
| GG-15 | GHG emissions from fuel consumption                | <ul style="list-style-type: none"> <li>It would be ensured that the construction contractor, where reasonable and feasible, would use electrical energy derived from a renewable energy source accredited by the National Green Power Accreditation Steering Group (or equivalent) for the supply of a proportion of the on-site electrical energy required during construction.</li> </ul> | Construction Contractor | Construction |
| GG-16 | GHG from embodied energy in construction materials | <ul style="list-style-type: none"> <li>Recycled materials would be used in construction material, wherever possible.</li> </ul>   | Construction Contractor | Construction |
| GG-17 | GHG from embodied energy in construction materials | <ul style="list-style-type: none"> <li>Surplus fill and waste material would be re-used on site.</li> </ul>   | Construction Contractor | Construction |
| GG-18 | Impacts during operation                           | <ul style="list-style-type: none"> <li>Pavement and structures along the road corridor would be inspected regularly and maintenance undertaken as necessary.</li> </ul>   | RMS                     | Operation    |

| Ref #              | Impact   | Environmental safeguards  | Responsibility | Timing           |
|--------------------|--|---|----------------|------------------|
| <b>Groundwater</b> |  |   |                |                  |
| GW-1               | Minor compaction of alluvial aquifers                                | <ul style="list-style-type: none"> <li>Culverts and diversion drains would be incorporated in fills to alleviate the impacts of ground compaction on shallow alluvial aquifers.</li> </ul>  | RMS            | Detailed design  |
| GW-2               | Road cuts intersecting shallow groundwater table and pile dewatering | <ul style="list-style-type: none"> <li>Detailed investigation of the depth to groundwater where cuts are proposed would be undertaken as part of the detailed design phase of the proposal. A series of piezometers would be installed along the road alignment to monitor ground water levels.</li> <li>Rising/falling head (slug) testing would be undertaken at selected bores to assess the hydraulic properties of aquifers where cuts and piles are proposed. Analytical modelling would be undertaken using this site specific hydraulic data to assess the volumes of groundwater that would need to be dewatered during construction and long-term operation of the proposal.</li> <li>Entitlements would be acquired for the volumes calculated in accordance with the Greater Metropolitan Region Water Sharing Plan and Aquifer Interference Policy so the volumes of groundwater that are dewatered are within the sustainable limits of the aquifer system and cause minimal harm.</li> </ul> | RMS            | Pre-construction |
| GW-3               | Removal of existing bores  | <ul style="list-style-type: none"> <li>Consultation with the owners of the bores to be removed would be undertaken prior to construction of the road upgrade. An alternative supply of water would be provided to bore owners if required.</li> </ul>   | RMS            | Pre-construction |
| GW-4               | Consultation with NSW Office of Water                                | <ul style="list-style-type: none"> <li>Liaison with the NSW Office of Water would be undertaken prior to construction of high risk activities to determine whether an aquifer access licence and/or and aquifer interference approval would be required.</li> </ul>   | RMS            | Pre-construction |

| Ref #                                | Impact                                      | Environmental safeguards  | Responsibility          | Timing                            |
|--------------------------------------|---|---|-------------------------|-----------------------------------|
| GW-5                                 | Groundwater quality                         | <ul style="list-style-type: none"> <li>The construction materials chosen for the piles for the bridge would consider groundwater quality, particularly aggressivity to concrete. Groundwater quality monitoring would be undertaken where the piles are to be constructed during the detailed design phase to assess aggressivity to concrete.</li> <li>On-site water management during construction of the bridge would ensure groundwater is of an acceptable quality prior to discharge to surface water systems or disposal. Treatment would be undertaken prior to discharge or disposal if required. Discussions will be held with the NSW Office of Environment and Heritage on the requirements to obtain an Environment Protection Licence.</li> </ul>   | Construction contractor | Pre-construction and construction |
| GW-6                                 | Abstraction of groundwater for construction | <ul style="list-style-type: none"> <li>All bores would be constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia (NUDLC, 2011).</li> <li>Bores would be sited away from local groundwater users in accordance with the works approval and all take of groundwater would be in accordance with licence conditions to minimise impacts.</li> </ul>   | Construction contractor | Pre-construction and construction |
| <b>Waste and resource management</b> |   |   |                         |                                   |
| WR-1                                 | Waste generation during construction        | <p>A WMP would be prepared as part of the CEMP prior to construction works commencing. The plan would detail standard environmental management measures to manage resource consumption and to avoid, re-use and dispose of waste during construction. These measures would include:</p> <ul style="list-style-type: none"> <li>Apply the waste hierarchy (avoid, minimise, reuse/recycle, dispose) during construction and implement through the CEMP.</li> <li>Prepare and maintain a waste management system (including recycling).</li> <li>Where disposal is required, classify, handle, store and dispose of waste in accordance with the DECC's (2008a) <i>Waste Classification Guidelines: Parts 1 and 2</i> and to a suitably licensed waste facility.</li> <li>Where practical, waste products would be reused on site, including: <ul style="list-style-type: none"> <li>Earthworks material as fill embankments.</li> <li>Sub-grade layers and other material for batter extensions.</li> <li>Top-soil for landscaping.</li> </ul> </li> </ul> | Construction contractor | Construction                      |

| Ref # | Impact                            | Environmental safeguards   | Responsibility | Timing    |
|-------|-----------------------------------|--|----------------|-----------|
|       |                                   | <ul style="list-style-type: none"> <li>○ Cleared vegetation would be mulched, chipped or composted to be used as sediment filter fences, landscaping or land rehabilitation.</li> <li>○ Crushed concrete as road base, footings, retaining walls, drainage.</li> <li>● Material not reused on site would be recycled at appropriate specialised off-site recycling contractors.</li> <li>● Treating any wastewater collected prior to discharge, in accordance with current standards.</li> <li>● Chipping leaf material and small branches of native vegetation for use as mulch in revegetation or landscaping works.</li> <li>● Disposing all other green waste from vegetation removal to a green waste recycling facility.</li> <li>● Work sites would be maintained in a tidy state and appropriately disposing of all general litter (including food scraps, plastics, glass bottle).</li> <li>● Chemical, fuel and lubricant containers and solid and liquid wastes would be disposed of in accordance with the requirements of OEH.</li> <li>● A licensed contractor would be used to remove contaminated waste, under current NSW legislative and OEH guidelines.</li> <li>● RMS contractors would be required to propose recycled-content materials where they are cost and performance competitive.</li> <li>● Site inductions would include training in waste minimisation principles.</li> </ul> |                |           |
| WR-2  | Waste generation during operation | <ul style="list-style-type: none"> <li>● Operational green waste from maintenance activities would be disposed of appropriately or reused where practicable.</li> <li>● Operational wastes, such as oils and greases, would be disposed of to an appropriate licensed facility.</li> <li>● Road user litter would be collected by the relevant maintenance organisation either for recycling or disposal to an appropriate facility.</li> </ul>  | RMS            | Operation |

| Ref #                  | Impact  | Environmental safeguards  | Responsibility                  | Timing                               |
|------------------------|---|---|---------------------------------|--------------------------------------|
| <b>Contamination</b>   |   |   |                                 |                                      |
| CM-1                   | Impact to potentially contaminated sites                      | <ul style="list-style-type: none"> <li>Further investigation would be undertaken on potentially contaminated sites. Implement of remediation would be employed as required, in accordance with OEH guidelines.</li> </ul>   | RMS                             | Pre-construction                     |
| CM-2                   | Land contamination during construction activities             | <ul style="list-style-type: none"> <li>Implementation of standard contingency measures in the CEMP (including for unknown contaminants, asbestos containing materials and site operations during construction) would occur to allow for further investigation and treatment/disposal as appropriate.</li> <li>All potentially contaminated wastes generated during construction works would be classified according to the (DECC 2008a) <i>Waste Classification Guidelines: Parts 1 and 2</i>. Dispose to a suitably-licensed disposal facility or reuse in the construction works as appropriate.</li> <li>Reuse or dispose of all road base/bitumen excavated as part of the road works would be in accordance with the DECC (2008a) <i>Waste Classification Guidelines 2008: Parts 1 and 2</i>.</li> </ul> | RMS                             | Construction                         |
| <b>Hazard and risk</b> |   |   |                                 |                                      |
| HR-1                   | Runoff of contaminated stormwater during construction         | <ul style="list-style-type: none"> <li>Temporary runoff detention basins would be provided during concept and detailed design.</li> <li>Sediment basins would incorporate accidental spill management containment of spills up to 40,000 litres through an appropriate baffle arrangement with an underflow or 'Ellis' pipes at the outlet end of the basin.</li> </ul>   | RMS and construction contractor | Detailed design and construction     |
| HR-2                   | Failure to identify risks in concept and detail design stages | <ul style="list-style-type: none"> <li>Undertake safety reviews and audits prior to construction.</li> <li>Undertake safety in design studies prior to construction.</li> </ul>   | RMS                             | Detailed design and pre-construction |
| HR-3                   | OHS for workforce   | <ul style="list-style-type: none"> <li>Undertake safety in design studies prior to construction.</li> </ul>   | RMS                             | Pre-construction                     |

| Ref # | Impact            | Environmental safeguards   | Responsibility          | Timing       |
|-------|-------------------|--|-------------------------|--------------|
| HR-4  | OHS for workforce | <ul style="list-style-type: none"> <li>• A construction safety management plan would be prepared prior to commencement of construction.</li> <li>• Compliance with statutory requirements, industry standards would occur throughout the construction of the proposal.</li> </ul>  | Construction contractor | Construction |
| HR-5  | Dangerous goods   | <ul style="list-style-type: none"> <li>• Dangerous goods wastes (if any) would be managed in accordance with the proposal CEMP.</li> <li>• Storage of any potentially dangerous goods on site would be undertaken in accordance with standards and statutory requirements.</li> <li>• Storage of materials would be away from migration paths and watercourses.</li> <li>• Goods used on site would be in accordance with manufacturers' instructions, good practice etc.</li> </ul> | Construction contractor | Construction |
| HR-6  | Hazardous wastes  | <ul style="list-style-type: none"> <li>• All hazardous wastes (if found) would be managed in accordance with the proposals' waste management plan.</li> <li>• Collection and secure storage systems would be developed for all potential hazardous wastes.</li> <li>• Any hazardous wastes (if any) would be disposed of by a licensed contractor to approved facilities.</li> </ul>   | Construction contractor | Construction |
| HR-7  | Other wastes      | <ul style="list-style-type: none"> <li>• All other wastes would be disposed of in accordance with the <i>Waste Classification Guidelines: Parts 1 and 2</i> (DECC 2008a). Disposal would occur to a suitably-licensed disposal facility or reused in the construction works as appropriate.</li> <li>• Disposal of all sanitary waste would be to an approved, off-site wastewater treatment plant.</li> </ul>   | Construction contractor | Construction |

| Ref # | Impact  | Environmental safeguards   | Responsibility                  | Timing                                      |
|-------|---|--|---------------------------------|---|
| HR-8  | Black ice formation   | <ul style="list-style-type: none"> <li>• Clearance of vegetation would typically only occur up to 5 metres from the top or toe of batters.</li> <li>• Formulation of an active black ice maintenance program would be undertaken as part of detailed design. As part of the formulation of a maintenance program, a suitable de-icing chemical would be identified (such as sodium chloride) for use during identified black ice events.</li> <li>• Installation of a weather station would be undertaken prior to construction. The weather station would obtain local meteorological data and provide warnings to motorists and alert RMS maintenance crews to the potential for black ice formation as part of the active maintenance program.</li> </ul> | RMS                             | Detailed design and construction            |
| HR-9  | Contaminated runoff from the roadway and dangerous goods spills | <ul style="list-style-type: none"> <li>• Sedimentation basins from construction phase would be incorporated into the permanent (operational) design.</li> <li>• It would be ensured that basins are regularly maintained to ensure they are effective during construction and operation of the road.</li> </ul>  | Construction contractor and RMS | Detailed design, construction and operation |

## 7 Conclusion

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This chapter provides the justification for the revised proposal taking into account its biophysical, social and economic impacts, the suitability of the site and whether or not the revised proposal is in the public interest. The revised proposal is considered in the context of the objectives of the EP&A Act, including the principles of ecologically sustainable development as defined in Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*.

### 7.1 Justification

The Great Western Highway is an important road corridor within both NSW and Australia. The section of highway under investigation for the overall upgrade is used by Blue Mountains and Lithgow residents for local trips as well as to access communities in the central west. The route is a major link in the NSW regional road network providing key freight transport link over the Blue Mountains. However, it has a disproportionate number of serious and fatal crashes due to its poor alignment, geometry, grades and other road conditions such as the formation of black ice during colder conditions.

The overall proposal would improve safety and travel efficiency within Forty Bends area by providing an improved alignment and grade in addition to providing measures that would assist in preventing the formation of black ice.

The determined proposal for a bridge crossing at Whites Creek includes the realignment of about 2.4 kilometres of the Great Western Highway from a point about 280 metres east of the eastern end of Forty Bends Road to a point about 50 metres west of McKanes Falls Road (the Forty Bends upgrade). The determined proposal was developed based on a concept design that was prepared using the available information and current design standards and criteria for the Great Western Highway upgrade program.

Following determination of the REF, an alternative design for the crossing of Whites Creek has been proposed. The revised proposal would provide additional potential safety improvements associated with a reduction in the risk from black ice. The additional thickness of ground cover above the proposed arch structure is more likely to mitigate potential effects of changes to cold flow characteristics which allow the formation of black ice. The revised proposal would also allow for potential cost savings for the overall project due to a reduction in construction and maintenance costs, whilst providing similar environmental outcomes through sensitive design.

## 7.2 Objects of the EP&A Act

Table 7-1 identifies the objectives of the EP&A Act and their relevance to the revised proposal.

**Table 7.1: Objectives of the EP&A Act 1979 and relevance to the revised proposal**

| Object  | Comment   |
|---|---|
| <p>5(a)(i) To encourage the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment.</p> | <p>The revised proposal design, impact mitigation and management measures, detailed in this REF addendum allow for the proper management, development and conservation of natural and artificial resources.</p> <p>The main objective of the overall Forty Bends Road Upgrade proposal is to provide a new alignment that would improve the safety and transport efficiency of the Great Western Highway.</p> <p>Where possible, throughout the detailed design of the alternative pre-cast concrete arch structure crossing over Whites Creek, management and conservation of natural resources would be incorporated. This would include optimising the opportunities for fauna crossing and revegetation of the impacted area to reduce the overall visual impact of the proposed embankment and pre-cast arch structure.</p> <p>It is recognised that there would be some impact on existing rural areas as a result of the proposed alternative pre-cast concrete arch structure design; however, this would not be significant at a regional level.</p> |
| <p>5(a)(ii) To encourage the promotion and co-ordination of the orderly economic use and development of land.</p>   | <p>The proposed alternative pre-cast concrete arch structure design would form an important element in the ongoing upgrade of the Great Western Highway throughout the Blue Mountains in NSW.</p> <p>The overall upgrade would assist in the coordination of the orderly economic use and development of land for the region and along this significant freight transport corridor.</p>   |
| <p>5(a)(iii) To encourage the protection, provision and co-ordination of communication and utility services.</p>  | <p>Utilities affected by the revised proposal would be relocated and maintained as required.</p>  |

| Object   | Comment   |
|--|---|
| 5(a)(iv) To encourage the provision of land for public purposes.   | The revised proposal is intended to be used for a public purpose.   |
| 5(a)(v) To encourage the provision and co-ordination of community services and facilities.   | <p>The overall Forty Bends Road Upgrade proposal would improve the access for the local community to access services and facilities in local towns Lithgow (to the west) or Katoomba (to the east) and the broader region.</p> <p>The alternative pre-cast concrete arch structure design across Whites Creeks forms part of this wider objective.</p>  |
| 5(a)(vi) To encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats. | <p>The overall Forty Bends Road Upgrade proposal has been designed to minimise impacts on the environment, including threatened species, populations and ecological communities and their habitats.</p> <p>Additional measures have been identified which would manage impacts during construction and operation of the alternative pre-cast concrete arch structure design across Whites Creek.</p>  |
| 5(a)(vii) To encourage ecologically sustainable development.   | Ecologically sustainable development is considered in sections 7.2.1–7.2.4 below.   |
| 5(a)(viii) To encourage the provision and maintenance of affordable housing.   | Not relevant to the revised proposal.   |
| 5(b) To promote the sharing of the responsibility for environmental planning between different levels of government in the State.  | Not relevant to the revised proposal.   |
| 5(c) To provide increased opportunity for public involvement and participation in environmental planning and assessment.   | <p>The overall Forty Bends Road Upgrade proposal development process allowed for consultation with relevant government agencies, non-government agencies and other community members and stakeholders.</p> <p>Consultation would continue during the detailed design, construction and operational phases of the overall project and specifically in relation to the alternative pre-cast concrete arch structure design across Whites Creek.</p> |

### 7.2.1 The precautionary principle

The precautionary principle deals with uncertainty in decision-making. It provides that if there is a threat of serious or irreversible environmental damage, a lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

As with the determined proposal, the alternative pre-cast concrete arch structure design would not threaten serious or irreversible environmental damage that would result in impacts of a permanent nature. All measures considered to be necessary to safeguard environmental values have been identified and included in preparation of this assessment. No serious or irreversible environmental damage is predicted to occur with the implementation of the identified environmental safeguards.

### 7.2.2 Intergenerational equity

Inter-generational equity is concerned with ensuring that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

The broader proposed upgrade of the Great Western Highway has been designed to benefit both existing and future generations through the provision of a higher standard, safer road with improved traffic flow efficiency. This would have direct and flow-on economic, social and wider environmental benefits including, but not limited to, improved inter-regional access, job creation during construction and reductions in per vehicle greenhouse gas emissions along the upgraded section of the highway. While the determined proposal and the alternative pre-cast concrete arch structure design would have some temporary and minor adverse impacts, these are not considered to be of a nature or extent that would disadvantage any sector of the community or future generations.

### 7.2.3 Conservation of biological diversity and ecological integrity

The conservation of biological diversity and ecological integrity was a fundamental consideration during the development of both the determined REF and this REF addendum for the alternative pre-cast concrete arch structure design. Conservation of biological diversity and ecological integrity has been considered at all stages of the proposed works and would be further considered during detailed design and construction of the alternative pre-cast concrete arch structure design as part of the overall proposal. Where possible, impacts to biological diversity and ecological integrity have been avoided and mitigated as outlined in this REF addendum and the determined REF.

### 7.2.4 Improved valuation, pricing and incentive mechanisms

The principle of improved valuation and pricing of environmental resources requires consideration of all environmental resources which may be affected by a proposal, including air, water, land and living things. While it is often difficult to place a reliable monetary value on the residual, environmental and social effects of the alternative bridge design, environmental and social issues were considered in the planning and establishment of the need for this activity. The value placed on environmental resources is evident in the extent of the planning, environmental investigations and design of management measures.

The alternative pre-cast concrete arch structure design has been designed to provide ongoing refinement of the proposed Great Western Highway upgrade and is therefore considered to be consistent with this principle.

### 7.3 Conclusion

The alternative pre-cast concrete arch structure design across Whites Creek for the upgrade of the Great Western Highway between Mount Victoria and Lithgow is subject to assessment under Part 5 of the EP&A Act. This REF addendum has examined and taken into account to the fullest extent possible matters affecting or likely to affect the environment by reason of the revised proposal above and beyond the existing approved investigations assessed as part of the determined REF.

The revised proposal would best meet the objectives of the overall upgrade of the Great Western Highway at Forty Bends and is anticipated to result in only minor environmental impact.

A number of potential environmental impacts from the proposed upgrade of the Great Western Highway at Forty Bends were previously identified during the assessment process of the determined REF and were avoided or reduced by appropriate mitigation measures. Mitigation measures as detailed in this REF addendum in addition to those previously identified in the determined REF would ameliorate or minimise these expected impacts.

The environmental impacts of the revised proposal are not likely to be significant and therefore it is not necessary for an environmental impact statement to be prepared and approval to be sought for the proposal from the Minister for Planning under Part 5.1 of the EP&A Act. The revised proposal is unlikely to affect threatened species, populations or ecological communities or their habitats, within the meaning of the TSC Act or FM Act and therefore an SIS is not required. The revised proposal is also unlikely to affect Commonwealth land or have an impact on any matters of national environmental significance.

Roads and Maritime has considered the potential need for the alternative pre-cast concrete arch structure design as part of the Forty Bends upgrade against its potential benefits and impacts, and has determined that the beneficial outcomes outweigh the potential adverse outcomes, provided adequate mitigation is implemented.

## 8 Certification

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This review of environmental factors provides a true and fair review of the proposal in relation to its potential effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposal.



Glyn Diwell  
Mount Victoria to Lithgow Alliance  
Date: 20/10/2014

I have examined this review of environmental factors and the certification by the Mount Victoria to Lithgow Alliance and accept the review of environmental factors on behalf of Roads and Maritime Services.



Chris Barnett  
Senior Project Manager, Project Delivery  
Roads and Maritime Services  
Date: 21.10.14

# References

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Roads and Maritime Services 2012a, *Forty Bends Review of Environmental Factors*  
– *Main report*

Roads and Maritime Services 2012b, *Forty Bends Review of Environmental Factors*  
– *Submissions Report*

## Terms and acronyms used in this REF

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|                   |   |
|-------------------|---|
| AusLink           | Mechanism to facilitate cooperative transport planning and funding by Commonwealth and state and territory jurisdictions  |
| CEMP              | Construction environmental management plan  |
| CTMP              | Construction Traffic Control Plan   |
| EIA               | Environmental impact assessment   |
| EP&A Act          | <i>Environmental Planning and Assessment Act 1979</i> (NSW). Provides the legislative framework for land use planning and development assessment in NSW.  |
| EPBC Act          | <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth). Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process. |
| FM Act            | <i>Fisheries Management Act 1994</i> (NSW)  |
| Heritage Act      | <i>Heritage Act 1977</i> (NSW)  |
| ISEPP             | State Environmental Planning Policy (Infrastructure) 2007   |
| LCZ               | Landscape Character Zone  |
| LEP               | Local Environmental Plan. A type of planning instrument made under Part 3 of the EP&A Act.  |
| NES               | Matters of national environmental significance under the Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> .  |
| NorBE             | Neutral or Beneficial Effect  |
| Noxious Weeds Act | <i>Noxious Weeds Act 1993</i> (NSW)   |
| NPW Act           | <i>National Parks and Wildlife Act 1974</i> (NSW)   |
| REF               | Review of Environmental Factors   |
| PEMP              | Project Environmental Management Plan   |
| SEPP              | State Environmental Planning Policy. A type of planning instrument made under Part 3 of the EP&A Act.   |
| SEPP 14           | <i>State Environmental Planning Policy No.14 – Coastal Wetlands</i>   |
| SIS               | Species Impact Statement  |
| TCP               | Traffic Control Plan  |
| TSC Act           | <i>Threatened Species Conservation Act 1995</i> (NSW)   |
| QA Specifications | Specifications developed by Roads and Maritime Services for use with roadworks and bridgeworks contracts let by Roads and Maritime Services   |

# Appendix A

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Consideration of clause 228(2) factors and matters of national environmental significance

## Clause 228(2) Checklist

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In addition to the requirements of the *Is an EIS required?* guideline as detailed in the REF, the following factors, listed in clause 228(2) of the *Environmental Planning and Assessment Regulation 2000*, have also been considered to assess the likely impacts of the proposal on the natural and built environment.

| Factor   | Impact                               |
|--|--------------------------------------|
| <p>a. Any environmental impact on a community?</p> <p>The proposed alternative pre-cast concrete arch structure design may cause some short term environmental impacts on the local community, in particular potential noise and vibration impacts, dust emissions and potential temporary disruption to traffic during construction. Potential impacts would be minimised with the implementation of the safeguards detailed in Table 5-1 of this REF addendum.</p>   | <p>Short-term, minor, negative</p>   |
| <p>b. Any transformation of a locality?</p> <p>The potential alternative pre-cast concrete arch structure design would be wholly undertaken within the determined proposal boundary of the Forty Bends upgrade.</p> <p>However, in the long-term the locality of the Whites Creek would be transformed through the construction of the proposed alternative pre-cast concrete arch structure including the placement of the pre-cast arch and earth embankments. This transformation is however considered to be moderate given that the proposal would follow the existing horizontal and vertical alignment of the determined proposal and be mitigated through sensitive design and planting.</p> | <p>Long-term, moderate, negative</p> |

| Factor   | Impact   |
|--|--|
| <p>c. Any environmental impact on the ecosystems of the locality?</p> <p>As the proposed alternative pre-cast concrete arch structure design would be wholly undertaken within the determined proposal boundary of the Forty Bends upgrade, no additional clearing of land would be required when compared to the determined proposal.</p> <p>Overall impacts to flora and fauna during construction of the alternative pre-cast concrete arch structure design are not considered to be major with the implementation of the proposed safeguards.</p> <p>The alternative proposal would have some minor negative impacts on the ability for fauna crossing within the Whites Creek locality when compared to the determined proposal as the embankment and pre-cast arch may provide an additional barrier. However, with the implementation of the safeguards identified in Table 6-1, and when considered in relation to the overall proposal, these impacts are not considered to be major.</p> <p>The proposed alternative pre-cast concrete arch structure design is therefore not anticipated to result in any additional environmental impact on the ecosystems of the locality other than those identified in the determined REF.</p> | <p>Short-term, minor, negative.</p> <p>Long-term, minor, negative.</p> |
| <p>d. Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality?</p> <p>During construction the proposed alternative pre-cast concrete arch structure design would have the potential to create a reduction in the existing aesthetic quality of the Forty Bends area as a result of dust and noise generation, visual impacts and increased traffic movements. These impacts would be minimised through the implementation of the proposed safeguards.</p> <p>In the short-term, the alternative pre-cast concrete arch structure design would result in a moderate reduction in the overall aesthetic quality of the Forty Bends area due to the placement of the earth embankment and the pre-cast arch within the Whites Creek corridor. However, in the long-term once planted vegetation has matured and the range of urban design safeguard measures have been implemented in the detailed design, these impacts are considered to be minor.</p>   | <p>Short-term, minor, negative</p> <p>Long-term, minor, negative</p>   |

| Factor   | Impact                        |
|--|-------------------------------|
| <p>e. Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations?</p> <p>The proposed alternative pre-cast concrete arch structure design would not impact on any know heritage sites, cultural heritage values places or buildings with an aesthetic, anthropological, archaeological, scientific or socially significant value. Sites in the vicinity of the proposal would be protected through the implementation of a range of safeguards outlined in the determined REF.</p> | <p>Nil additional impacts</p> |
| <p>f. Any impact on the habitat of protected fauna (within the meaning of the <i>National Parks and Wildlife Act 1974</i>)?</p> <p>The alternative pre-cast concrete arch structure design would not have any impact on the habitat of any protected or endangered fauna. Any vegetation to be removed would be undertaken as part of the determined REF and has been assessed previously.</p>   | <p>Nil additional impacts</p> |
| <p>g. Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air?</p> <p>The proposed alternative pre-cast concrete arch structure design is not expected to endanger any species of animal, plant or other form of life, whether living on land, in water or in the air. There would be no significant impact on protected or endangered species, communities or habitats.</p> <p>Potential impacts would be minimised with the implementation of the safeguards detailed in Table 6-1 of this REF.</p>  | <p>Nil additional impacts</p> |
| <p>h. Any long-term effects on the environment?</p> <p>The proposed pre-cast concrete arch structure design would not have any long-term effects on the environment.</p>   | <p>Nil impacts</p>            |
| <p>i. Any degradation of the quality of the environment?</p> <p>As the proposed alternative pre-cast concrete arch structure design would be wholly undertaken within the determined proposal boundary of the Forty Bends upgrade, it is anticipated that there would be no additional degradation of the quality of the existing environment other than that identified in the determined REF.</p>  | <p>Nil additional impact</p>  |
| <p>j. Any risk to the safety of the environment?</p> <p>As the alternative proposed pre-cast concrete arch structure design would be wholly undertaken within the determined proposal boundary of the Forty Bends upgrade, it is anticipated that there would be no additional risk to the safety of the environment other than that identified in the determined REF.</p>   | <p>Nil additional impacts</p> |

| Factor  | Impact                             |
|---|------------------------------------|
| <p>k. Any reduction in the range of beneficial uses of the environment?</p> <p>The alternative pre-cast concrete arch structure design would not result in any reduction in the range of beneficial uses of the environment.</p>  | <p>Nil additional impacts</p>      |
| <p>l. Any pollution of the environment?</p> <p>The alternative pre-cast concrete arch structure design is unlikely to cause any significant pollution if the environment if the safeguards detailed in Table 6-1 of this REF addendum are implemented and maintained.</p> <p>Some noise pollution and localised dust may be generated by the works however this would be for a short term period only whilst the construction of the alternative pre-cast concrete arch structure design is being undertaken.</p> | <p>Short-term, minor, negative</p> |
| <p>m. Any environmental problems associated with the disposal of waste?</p> <p>No environmental problems are anticipated for the disposal of waste as a result of the alternative pre-cast concrete arch structure design. Potential impacts would be minimised with the implementation of the safeguards detailed in the determined REF.</p>   | <p>Nil additional impacts</p>      |
| <p>n. Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply?</p> <p>The alternative pre-cast concrete arch structure design would not increase demands on resources, which are, or are likely to become, in short supply.</p>  | <p>Nil additional impacts</p>      |
| <p>o. Any cumulative environmental effect with other existing or likely future activities?</p> <p>No additional cumulative environmental effect with other existing or likely future activities are anticipated beyond those identified within the determined REF as a result of the alternative pre-cast concrete arch structure design.</p>   | <p>Nil additional impacts</p>      |
| <p>p. Any impact on coastal processes and coastal hazards, including those under projected climate change conditions?</p> <p>The proposal is not located within a coastal area and would not result in any impact on coastal processes and coastal hazards.</p>   | <p>Nil impact</p>                  |

# Matters of National Environmental Significance

Under the environmental assessment provisions of the *Environment Protection and Biodiversity Conservation Act 1999*, the following matters of national environmental significance and impacts on Commonwealth land are required to be considered to assist in determining whether the proposal should be referred to the Australian Government Department of Sustainability, Environment, Water, Population and Communities.

| Factor  | Impact       |
|---|--------------|
| <p>a. Any impact on a World Heritage property?</p> <p>The proposal would not have any impact on a World Heritage property. The closest World Heritage property to the proposal is the Greater Blue Mountains National Park, located about 11 kilometres to the east of the proposal.</p>  | Nil impact   |
| <p>b. Any impact on a National Heritage place?</p> <p>The proposal would not have any impact on a National Heritage place. The closest National Heritage place to the proposal is the Greater Blue Mountains National Park, located about 11 kilometres to the east of the proposal.</p> <p>The Hartley Valley (located within 10 kilometres of the proposal to the east) has also been nominated for inclusion as a National Heritage place, however the status for this nomination is yet to be determined.</p>   | Nil impact   |
| <p>c. Any impact on a wetland of international importance?</p> <p>The proposal would not have any impact on a wetland of international importance. There are no wetlands of international importance within 10 kilometres of the proposal site.</p>   | Nil impact   |
| <p>d. Any impact on a listed threatened species or communities?</p> <p>A number of threatened species and communities were identified as having the potential to occur within 10 kilometres of the proposal as part of the determined REF. Of particular importance is nationally listed (Vulnerable under the EPBC Act) Purple Copper Butterfly (<i>Paralucia spinifera</i>) which has been identified within the overall proposal site for the Forty Bends upgrade.</p> <p>The determined REF noted that proposal would not have any substantial impact on any threatened species or communities. Notwithstanding, the proposal would have the potential to negatively impact on the habitat of listed threatened species under the EPBC Act 1999. (refer to section 6.1 of the determined REF).</p> <p>The proposed alternative pre-cast concrete arch structure design would be within the proposed footprint of the wider Forty Bends upgrade and would not result in any addition impact to a listed threatened species or communities.</p> | Minor impact |

| Factor   | Impact            |
|--|-------------------|
| <p>e. Any impacts on listed migratory species?</p> <p>The proposal would not have any impact on any listed migratory species. Refer to section 6.1 of the determined REF.</p>                                  | <p>Nil impact</p> |
| <p>f. Any impact on a Commonwealth marine area?</p> <p>The proposal would not have any impact on a Commonwealth marine area. No Commonwealth marine areas occur within 10 kilometres of the proposal site.</p> | <p>Nil impact</p> |
| <p>g. Does the proposal involve a nuclear action (including uranium mining)?</p> <p>The proposal does not involve a nuclear action.</p>  | <p>Nil impact</p> |
| <p>Additionally, any impact (direct or indirect) on Commonwealth land?</p> <p>The proposal would not impact on Commonwealth land.</p>  | <p>Nil impact</p> |



# Appendix B

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Ecological technical memo

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Roads and Maritime  
101 Miller Street  
North Sydney NSW 2060

16/10/2014

NB11343.RS021

**RE: Review of alternate connectivity designs for Whites Creek – Forty Bends upgrade  
Great Western Highway**

Please find attached my report reviewing the alternative design options that are proposed for crossing of Whites Creek associated with the Forty Bends upgrade of the Great Western Highway.

Yours sincerely

A handwritten signature in black ink that reads "Chris Thomson". The signature is written in a cursive style and is enclosed in a light grey rectangular box.

**Chris Thomson**  
Associate Ecologist  
0427 603 188  
chris.thomson@jacobs.com



## **1. Introduction**

### **1.1 Background and purpose of the review**

The Review of Environmental Factors (REF) for the Great Western Highway upgrade, Forty Bends upgrade (RMS 2012) assessed the impacts of the upgrade on threatened flora and fauna based in the context of a number of specific biodiversity mitigation measures. This included the provision of both dedicated and combined structures for facilitating fauna movements across the road, including terrestrial and arboreal mammals. The suite of design measures included a bridge over Whites Creek, which had a combined hydrology and fauna crossing purpose through the retention of adequate space under the bridge for fauna movements and the addition of a suspended rope ladder for use of arboreal mammals and connected to adjoining remnant trees.

There are currently limited opportunities for fauna movements across the existing highway and no purpose built fauna crossing structures or exclusion fencing in this location, and therefore the upgrade will improve fauna connectivity in this location. The biodiversity connectivity strategy for the project, as put forward in the REF, aimed to mitigate the barrier effect of the highway upgrade by including two fauna underpasses, canopy rope bridges at Whites Creek and glider poles located near the western fauna underpasses. The connectivity measures developed by RMS were accompanied with a set of design principles that were outlined in the REF and the Commonwealth to be adhered to as part of detailed design.

An alternate design option for Whites Creek has been put forward. This brief report assesses the potential impacts of the alternate connectivity design option compared with the original design for inclusion in the addendum REF and considers any change to connectivity and vegetation impacts for listed threatened species as assessed in the REF.

### **1.2 Connectivity design options**

#### **1.2.1 Concept design (REF)**

The original design option assessed in the REF included twin bridges over Whites Creek with an overall length of 150 metres and a height under the bridge ranging from 6 m to 15 metres. The bridge would be placed to the south of the existing section of highway, and the existing disused road surface ripped and revegetated to improve connectivity in this location. The design included a rope crossing structure for arboreal mammals in the form of ropes suspended by poles under the bridge and connecting to nearby vegetation north and south of the bridge at select locations which were to be tied in with remnant and mature trees. The poles holding the rope could also be used by gliders, however the main glider poles were positioned to the west and not associated with Whites Creek.



Scour protection was not originally proposed along Whites Creek for the concept design due to the retention of the natural ground below the bridge which would allow for overland flow.

### **1.2.2 Alternate design option**

The proposed alternative design retains the same alignment over Whites Creek however replaces the twin bridges with a proposed new embankment and pre-cast arch over Whites Creek. The precast arch would be constructed on piled footings with an earth fill embankment and reinforced earth walls. The proposed arch is about 17 m wide, 7.5 m high and 51 metres long. Reinforced soil walls are required around the lower perimeter of the embankment, particularly around the property boundary to the south of the site. The extent of these walls has been assessed and heights up to about 14 metres have been determined. Batter slopes of 2:1 above the wall and 3:1 below the wall are proposed. Scour protection is also proposed for Whites Creek within the arch structure. Connectivity options for gliders will include the retention of the rope crossing ladder if feasible.

## **2. Assessment of alternative design option**

### **2.1 Review of likely design effectiveness**

#### **2.1.1 Structure size**

It is likely that the arch structure will provide a suitable alternative passage for fauna to the bridge, this would include the threatened Spotted-tailed Quoll (*Dasyurus maculatus*) and Koala (*Phascolarctos cinereus*) assessed as likely to occur in the REF. These large arch structure types have been known to provide passage for a range of fauna although there are some key elements that are required to make it more effective. This would involve vegetation retention and planting at the approaches to the structure, retaining natural vegetation within the structure or as natural surface as possible.

Dimensions of the arch are large enough for fauna passage (7.4 metres high x 17.0 metres wide), although the extent of rock scour protection required along Whites Creek may reduce the overall internal width down to less than 10 metres creating fauna passage that is dominated by rock. This is compared to the bridge design which allowed at least 100 metres for crossing opportunities and a large amount of light spill under the structure to assist vegetation growth. This issue is able to be mitigated by designing a minimum of about 3 metres natural bank either side of the creek.

Structure length is about 51 metres which would be suitable for effective fauna passage.



## **Mitigation**

Scour protection associated with the entries and exits to the arch must accommodate and provide for the safe and effective passage of fauna, be constructed with the smallest reasonably possible rock size, be as level as possible and have minimal gaps between the rocks. Consideration must be given to the use of concrete paths or other suitable surfaces in the scour protection to provide for the safe and effective passage of fauna. Scour protection needs to allow as a minimum 3-4 metres between the scour protection and the arch wall.

### **2.1.2 Proposed embankment**

Considering the location of the road in relation to the steep topography, the proposed high batter and retainer walls would provide substantial shading adjacent to the road, particularly on the southern side. This may impact on any existing trees or native vegetation in this location through a change in microclimate conditions and is likely to create poorer conditions for native vegetation re-growth and any landscape plantings required to assist fauna passage. The REF and referral included commitment for a landscape management plan including revegetation at Whites Creek as an integral part of improving wildlife connectivity. The amended design is unlikely to be conducive to revegetation in this location compared with the bridge design.

## **Mitigation**

A landscape / revegetation plan is required to detail the steps and species required for revegetation adjoining the retaining wall and both sides of the structure. Consideration will need to be given to weed management and site preparation prior to planting, and the species selection will need to consider local plant species that are expected to survive the low light conditions on the southern side of the road.

### **2.1.3 Connectivity for fauna**

At a site meeting on 11 July 2012 to assess the original bridge design, it was identified that there was limited opportunity to tie the rope crossing structures in with remnant trees due to the lack of trees close to the proposed bridge. The best opportunity was to tie in the ropes with a few large trees at the eastern end of the bridge. There is a need to view the tree survey to determine opportunity to placing rope structures through the arch. A recommendation from the site meeting was to complete a tree survey as part of detailed design and identify individual trees that could be retained during construction as these are critical for the structures success. The ongoing health of remnant trees may be compromised by the lengthy batter and high retaining wall.

The target threatened species were Spotted-tailed Quoll and Koala and potentially the Yellow-bellied Glider. There is concern that the arch structure may not be suitable for gliders, although



the other two species are suited to both designs (refer AMBS 2001 and RTA 2009). The rope structure will need to be redesigned to suit the arch, however this may not be feasible.

The change to the alternative design does not change the conclusions of the Assessment of Significance for threatened fauna, in particular due to the extent of other measures proposed for connectivity on this project. The bridge was seen to be an addition to these dedicated structures and not a dedicated structure. In the event that the rope structure is not feasible, this is not considered to be a significant issue as the main structure for gliders was positioned to the west of the bridge where connectivity is optimum and this structure would not be removed by the alternate design.

### **Mitigation**

The alternative design will require a re-design of the rope crossing structure to traverse through the arch. In particular a further site assessment and survey of remnant trees is required to identify opportunities to link the rope structure to remnant forest and not isolated or immature trees. This measure may be deemed to be unfeasible upon further re-survey. In this event, the absence of the rope structure is not considered to significantly alter the findings of the REF. This is due to the fact that alternate targeted arboreal structures are being used on this project in locations considered optimum for fauna crossing and the Whites Creek area was considered supplementary to these targeted structures.

#### **2.1.4 Landscaping / revegetation**

It was also agreed at the meeting held in July 2012 that the ground beneath the Twin Bridges over Whites Creek is to be landscaped with "boulders" rather than vegetation. This was a good idea given the extent of land under the bridge available for fauna, but this is not suitable for the arch design, as discussed previously. Recommend reviewing the extent of scour protection, however this should be feasible and would not be an impact for fauna provided it is designed suitably.

It appears that the structure would be under water in the 100 yr flood event, and therefore fauna passage cut-off. Expect that this would only be a brief event and drain away quickly. The flood level may be too high to design a concrete ledge and mitigation is not required.

### **Mitigation**

It is highly unlikely that vegetation would survive inside the arch structure and the floor would become an unnatural surface with rocks. Recommend careful consideration of plant species to be used inside the arch and to the approaches. A landscape / revegetation plan is required to details the steps and species required for revegetation adjoining the retaining wall and both sides of the structure. Consideration will need to be given to weed management and site preparation prior to



planting, and the species selection will need to consider local plant species that are expected to survive the low light conditions on the southern side of the road.

### **2.1.5 Vegetation**

The vegetation adjacent to the proposed land bridges was ground-truthed during the REF and identified as largely cleared and modified albeit for small isolated patches of remnant forest that are not listed Endangered Ecological Communities (TSC Act or EPBC Act). Vegetation is dominated by weeds at the bridge site, particularly blackberry, with some isolated trees and small patches of trees. There is unlikely to be a significant change in the impact to existing vegetation associated with the alternative design from what was assessed in the REF. The trees in proximity to the construction boundary were surveyed and mapped as part of the REF concept design and based on this data up to six trees may need to be cleared to accommodate the alternate design. This change in impact from the REF is minimal and does not alter the conclusions of the Assessment of Significance completed for threatened species. This is a result of the lack of natural vegetation at the site, and the fact that the alternate design will remain on the same alignment.

### **Mitigation**

Natural vegetation is to be retained where possible during construction, in particular any remnant trees adjacent to the road corridor.

### **2.1.6 Aquatic fauna**

As Whites Creek is an ephemeral drainage line and does not provide habitat for a listed threatened species of fish, the proposed alternative design would not impact on the habitat for a threatened species.

### **2.1.7 Purple Copper Butterfly**

The extent of potential habitat for the Purple Copper Butterfly (PCB) was identified and mapped in the REF. the alternative design was overlaid onto the spatial data and shows that there will be no additional clearing of this habitat to accommodate the design. Therefore this design is consistent with the conclusions of the Assessment of Significance for PCB put forward in the REF.

A key feature of the habitat for this species is warm basking sites and therefore it is critical that any change to the design will maintain open sunny habitats for this species where potential habitat was identified. The REF identified potential habitat along the slope to the north of the Whites Creek crossing, while high and occupied habitat was identified further west and east of this site. Potential habitat was not identified at the bridge site itself.



The height of the proposed embankment will likely result in shadowing adjacent to the road particularly compared with the bridge. Shadowing would likely be greater on the south side of the embankment than the north side and there is no potential habitat for the PCB on the south side. There is potential for shadowing on the north side, however any change in light spill onto the northern slope, would likely be minimal given the distance of the potential habitat for PCB from the proposed road corridor and the fact that the new alignment will be moved to the south of the current alignment and further down slope than the current highway.

The extent of potential habitat identified in the REF for PCB in this location was restricted to the road edge which was the limit of the survey. It is likely that this habitat extends further north up to the ridge line across the northern slopes and would be more extensive than mapped in the REF with greater distance from the road.

A referral to the Commonwealth for the Forty Bends upgrade was approved in May 2014 and an offset strategy prepared to address the potential impacts of the project. The alternate design does not alter the conclusions and mitigation measures presented in the referral with respect to the impacts on this species.

## **2.2 Conclusions**

It is likely that the arch structure will provide a suitable alternative passage for fauna to the bridge. These large arch structure types have been known to provide passage for a range of fauna although there are some key elements that are required to make it more effective. This would involve vegetation retention and planting at the approaches to the structure, and providing a natural substrate within the structure or as natural surface as possible.

It is also recommended that consideration be given to the extent of scour protection in order to retain a natural substrate for fauna passage and that a new rope crossing be designed that traverses under the arch structure. A site specific revegetation plan is required to inform the actions and species selection required for revegetation north and south of the embankment and approaches to the arch.

Provided that these recommendations are included in the new design, this structure is considered to be a suitable alternative and would be consistent with the conclusions of the Assessment of Significance for Spotted-tailed Quoll, Koala, Yellow-bellied Glider and Purple Copper Butterfly detailed in the REF.



### **3. References**

Australian Museum Business Services (2001) 'Fauna underpass monitoring Stage One – Final Report - Brunswick Heads. Roads and Traffic Authority.' Australian Museum Business Services, Sydney, NSW.

RTS (2009) Use of fauna passage structures on RTA roads. Summary report March 2009. Roads and Traffic Authority.



# Appendix C

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## Statement of Heritage Impact

# Addendum to Statement of Heritage Impact

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Great Western Highway Upgrade  
Mount Victoria to Lithgow  
Forty Bends Upgrade

Review of Environmental Factors  
Technical Paper 4



*View to northeast in general location of Whites Creek and the revised proposal.*

Report to  
**Parsons Brinkerhoff**  
On behalf of  
**Roads and Maritime**  
  
**October 2014**

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# Forty Bends Upgrade – Review of Environmental Factors Addendum Historical or European Heritage & Archaeology

## 1.0 Background

### Background

This report is an Addendum to: *Great Western Highway Upgrade, Forty Bends Upgrade, Review of Environmental Factors, Technical Paper 4, Statement of Heritage Impact* (August 2012). This addendum report provides a review of issues associated with a revised proposal for the bridge at Whites Creek. This letter report has adopted sections of Technical Paper 4 (2012) for this report or referred to sections of the 2012 report. As part of this reporting the Landscape Character & Visual Impact Assessment report was reviewed and its mitigations strategies adopted.

## 2.0 The Proposal

The revised proposal identifies a new arch and embankment in replacement of the approved bridge across Whites Creek.

### Overview of the proposed pre-cast arch and embankment

The alternative to the current five-span bridge design over Whites Creek includes a precast concrete arch on piled footings with earth fill embankment and reinforced earth walls.

### Design of the proposed pre-cast arch and embankment

The proposed alternative bridge design includes (Figure 1, Figure 2, Figure 3, Figure 4):

- A pre-cast arch 17m wide and 7.5m high. Piled footings have been chosen to limit the differential settlement across the arch to within 5mm, with the foundations consisting of bored piles of rock with a reinforced concrete capping beam.
- Reinforced earth walls around the lower perimeter of the embankment, particularly around the property boundary to the south of the site. The extent of these walls has been assessed and heights up to 14m have been determined
- Batter slopes of 2:1 above the wall and 3:1 below the wall.
- Scour protection in front of the foundations to protect the arch from any undermining during a flood event.

### 3.0 Heritage Sites

As identified in Technical Paper 4 the old line of the 1830s Mitchell's road runs to the south of the revised proposal. This section of 1830s road was identified during the various stages of heritage reporting. The historical background for this section of road is Section 3.2 of the REF (2012).

#### Field Survey of Forty Bends Road<sup>1</sup>

Forty Bends Road is a bypassed section of Mitchell's 1830s road which contains the remains of five culverts and cuttings where the road was terraced into the foothills of Hassans Walls (Table 3.1; Figure 5, Figure 6, Figure 7, Figure 8). Two of these culverts are modern and three contain surviving elements of the original structure (Table 3.1). It is noted that the description of the culverts has changed since 2008 and 2011, as we were able to gain access to these areas in the November 2011 and February 2012 surveys due to Council road works which cleared vegetation away and made elements visible, although some culverts and their retaining walls were still difficult to photograph.

Table 3.1: Culverts on Forty Bends Road and their condition.

|           | Upslope                     | Downslope       |
|-----------|-----------------------------|-----------------|
| Culvert 1 | modern concrete             | modern concrete |
| Culvert 2 | possibly original sandstone | modern concrete |
| Culvert 3 | original sandstone          | modern concrete |
| Culvert 4 | original sandstone          | modern concrete |
| Culvert 5 | original sandstone          | modern concrete |

Culvert 4 is just to the west of the entrance to Monte Vista where there is a substantial earthen cutting (Figure 5). The downslope sides of Culverts 4 and 5 are within the Monte Vista property. Moving westwards are more cuttings and the substantial remains of Culvert 5 (Figure 7, Figure 8, Figure 9, Figure 10). The northern side of Culvert 5, adjacent to the revised proposal, is a sandstone retaining wall (Figure 9) while the southern side is a modern concrete rebuild (Figure 10). The original section of road has been slightly bypassed in this area and the northern side of the culvert is located a few metres to the north of the road. Culvert 5 is on a bend in the road where Whites Creek passed underneath the 1830s road (Figure 11, Figure 12, Figure 13). This area has the characteristics of 'country lane' appearance typical of surviving segments of early road. See Technical Paper 4 for further details on this section of road (2012: 29-40).

<sup>1</sup> This section is extracted from Section 3.2.3 of Technical Paper 4.

## 4.0 Heritage Assessment

### Heritage Significance

The following Statement of Significance was written for this section of 1830s Mitchell's road in Technical Paper 4 (2012:41-44). It was identified as having, at a minimum, a local level of significance and it may, upon further research into other surviving sections of road, reach the State significance threshold.

### Statement of Significance

The road at Forty Bends is part of the original sections of Mitchell's road which was built in the 1830s from Mount Victoria to Bathurst. It is associated with Surveyor-General Thomas Mitchell, his choice of a new road alignment over Victoria Pass to Bathurst in the 1830s and the opening up of New South Wales to the west of the Blue Mountains. These works were undertaken by convict work gangs, mostly ironed gangs, and was part of a hard labour system of punishment. The convicts and soldiers lived at the nearby Hassans Walls stockade or Bridge/Road Party site. The choice of this road alignment meant facing the difficulty of crossing the footslopes of Hassans Walls which required a series of bridge and culvert crossings, remains of which survive at Forty Bends. This road illustrates elements of a narrow country lane - road cuttings and culverts with stone retaining walls. These remains are part of sections of Mitchell's road which survive within the Lithgow City Council area and elsewhere along the route, some of which have more substantial engineering works. It is representative of the more typical elements of the road. The alignment has had some minor adjustments and only the upslope side of three of the culverts and walls remain. This section of road is expected to have significance to the local community. The identification of a level of significance for Forty Bends Road is difficult without broader research. It has at a minimum a local level and depending upon overviews of it within the context of other elements of Mitchell's Road, it may reach the State significance threshold.

## 5.0 Impacts of the Proposal

### VISUAL ISSUES

#### Spakman Mossop and Michaels Assessment of Visual Impacts

For analysis of visual issues in this Addendum we have relied on the analysis by Spakman Mossop and Michaels (SMM, October 2014). They have made the following observations which are key to the heritage impact assessment of this report:

- 'That the extensive fill embankments and retaining walls will be up to 14m high' (2014:8). These walls are quite close to Forty Bends Road.
- 'It is estimated that at least six additional mature native trees would be required to be removed along the northern edge of Forty Bends Road for the construction of the proposed alternative bridge' (2014:8).
- 'However, the extent of the embankments would be greater than the previous design, although new tree and shrub planting on these would, over time, integrate the embankments with the vegetated slopes of Hassans Walls. However, the 14 metre high reinforced earth walls around the arch would be out of character with the existing landscape character and would require the removal of additional native trees, particularly along the boundary of Forty Bends Road...' (2014:8).
- The close proximity of the proposed reinforced earth wall to Forty Bends Road will restrict the potential for any tree and shrub planting between the wall and the road, exposing the wall to motorists which will have a highly adverse visual impact...(2014:8).

In terms of views the most relevant is Viewpoint 5 (2014:12). This view is immediately east of Whites Creek and is the same view as Figure 13. The elevation indicates that the retaining wall would start in this area and increase in height to the east. SMM indicates that plantings will assist to 'integrate the embankments with the vegetated slopes of Hassans Walls' over time. While it is indicated that the choice of recessive colours for materials 'would potentially reduce the visibility of the reinforced and concrete arch, however, they would remain highly visible' if the mature trees lining the road were removed. This is because of the closeness of the wall to Forty Bends Road and the lack of space for screen planting. The impact of the proposal on this view is considered to be High to Moderate.

In summary the visual impacts from the revised proposal are:

- Impact on views by a high retaining wall close to Forty Bends Road in an important viewing point.
- Likely removal of up to six mature trees which are key elements contributing to the 'country lane' aspect of Forty Bends Road.

### HERITAGE ISSUES – VISUAL AND FABRIC

The proposal extends the footprint of the proposed works into the current road reserve for Forty Bends Road and closer to Culvert 5, Forty Bends Road (Figures 1, 2). Culvert 5 is located within the road reserve (Figure 5) and a 5m buffer has been established between it and the new arch. The height of arch at this point is 7.5m. The design option of the arch was investigated with a 10m buffer from Culvert 5; however the retaining walls would be about 18m high. This was considered to have a greater impact on the surrounding landscape character. Therefore a 5m buffer with a lower arch was considered to be more suitable for the landscape character of the country lane and still provide a gap between the culvert and the new design. Also offsetting the location of the arch in relation to Culvert 5 was considered but it would produce a high wall immediately behind the arch and change the hydrology in the area. This was not considered an acceptable solution.

The revised design provides for the retention of the surviving section of culvert but appears to have a high level of impact on the country lane appearance of the roadway in the area of Figure 13 and to the east (Figure 12). As shown in Figure 4 the embankment is very close to the existing line of Forty Bends Road at the western end and is a few metres from the western end of the road. The proposal is considered likely to have a major visual impact on the significance of this surviving section of Forty Bends Road. The impact on Culvert 5 is minor as the culvert is not intended to be visible in the landscape.

Another issue is the potential impact from construction of the revised design. The revised proposal does not require construction trucks to access the works site from Forty Bends Road. All site access will be from the Great Western Highway. This strategy therefore removes risks associated with inadvertent accidents to cuttings and increased loads on a narrow section of road which may impact on the fabric of the road.

Culvert 5 and Forty Bends Road are part of a surviving section of 1830s convict-built Mitchell's Road and the removal of the culvert would impact on this section of the road and its significance generally. The main issue of concern from the revised proposal is the retention of the country lane character of the road. The main impact noticeable to someone driving on this section of early roadway would be visual impacts to the country lane character of the road. The revised design retains the culvert but involves major visual impacts by dominating the road where currently it was open country side. The previous proposal had less visual impact on the heritage road as it was set back from the road (Figure 5).

As noted above this section of Forty Bends Road is at least of local significance and may potentially be of State significance but such analysis requires further research. The proposal has considerable impact on the significance of Forty Bends Road. It is essential that the road retain this significance following the construction of the new embankment. . Therefore the proposed mitigation must ensure not only the retention of Culvert 5 but also the country lane aspect of the road which is derived from the 1830s road alignment, the narrow width of the road, the mature native trees alongside the road, and the road cuttings, as well as glimpses through to the grass paddocks.

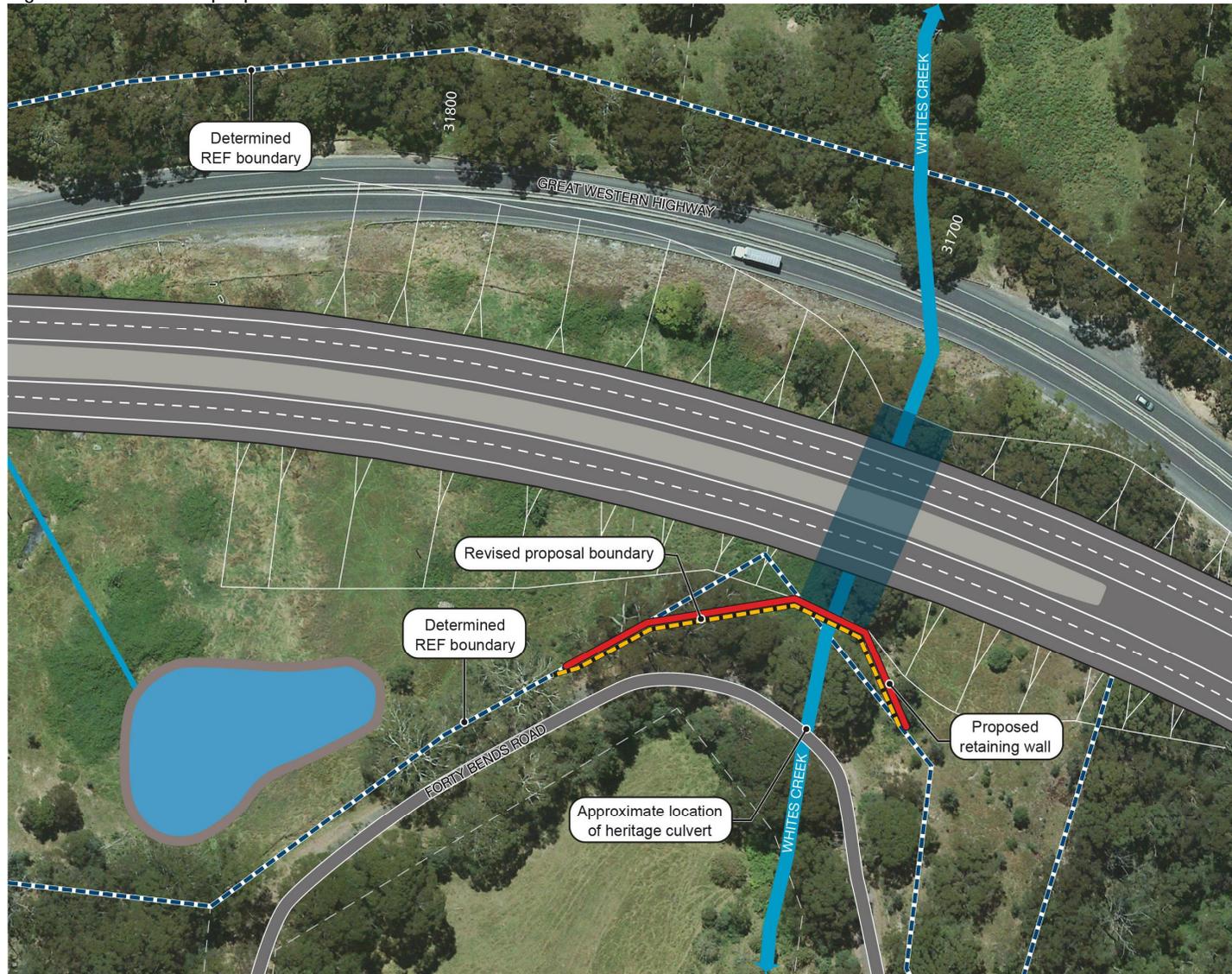
## 6.0 Mitigation of Impacts

The design of the revised proposal has avoided direct impact on Culvert 5 but currently has major impacts on Forty Bends Road at Viewpoint 5 where a retaining wall and embankment is proposed to be introduced and mature native trees lining the road are likely to be removed. The following strategies should further minimise impacts from the revised proposal:

1. A buffer of 5m distance between the new arch and the footprint of the embankment should be maintained so as not to provide physical and visual dominance over Culvert 5 and the 1830s line of road. Detailed design must ensure that there will be no impacts on Culvert 5 or Forty Bends Road.
2. The mitigation strategies identified in SMM October 2014 report are considered essential to mitigating impacts to the visual elements of the significance of the road. These are essential to the road retaining its local significance.
3. Mitigation of impacts during construction should include:
  - Resolution of urban design issues to minimise visual impacts to the county lane character of Forty Bends Road.
  - Fencing of areas where there should be no impact to trees, roadway or culverts.
  - Fencing to protect Culvert 5 during construction.
  - Vibration management to protect Culvert 5 during construction.
  - Induction for works crews to include the need to protect the culvert.
  - Fencing to protect mature trees during construction.

4. If the revised proposal is commissioned then at the 20 per cent design stage there should be a further assessment of the impacts of the revised proposal to determine if the required mitigation necessary to retain significance has been met. This should include photographic panorama of the area at Viewpoint 5 and to the east to Whites Creek. If at this time the impact is considered to impact on significance then need to consider an alternative design.

Figure 1: The revised proposal.



# OPTION 1

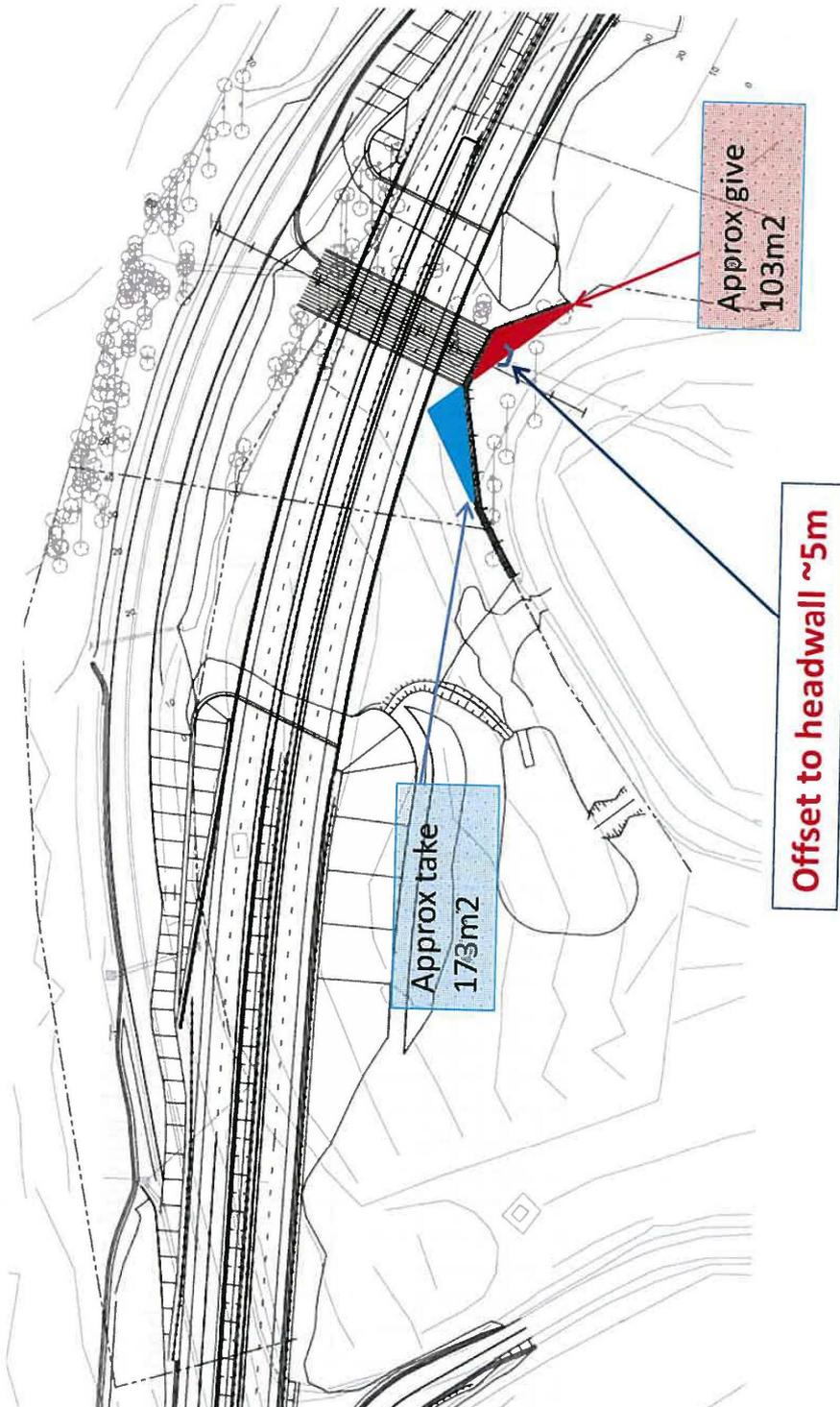


Figure 2: Footprint of the revised proposal in relation to Culvert 5. The extent of the footprint of the revised proposal extends to the south into the road reserve of Forty Bends Road.

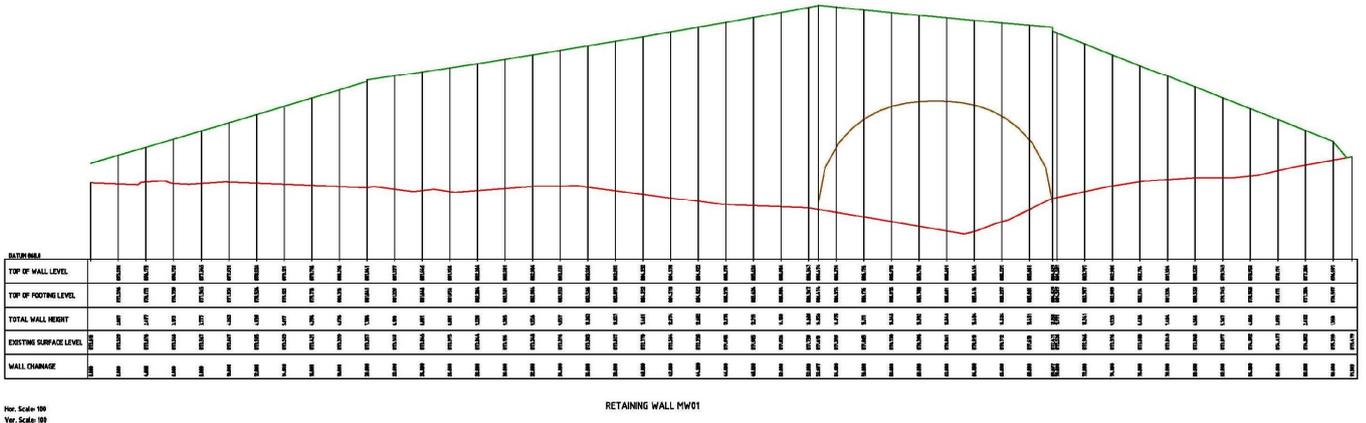
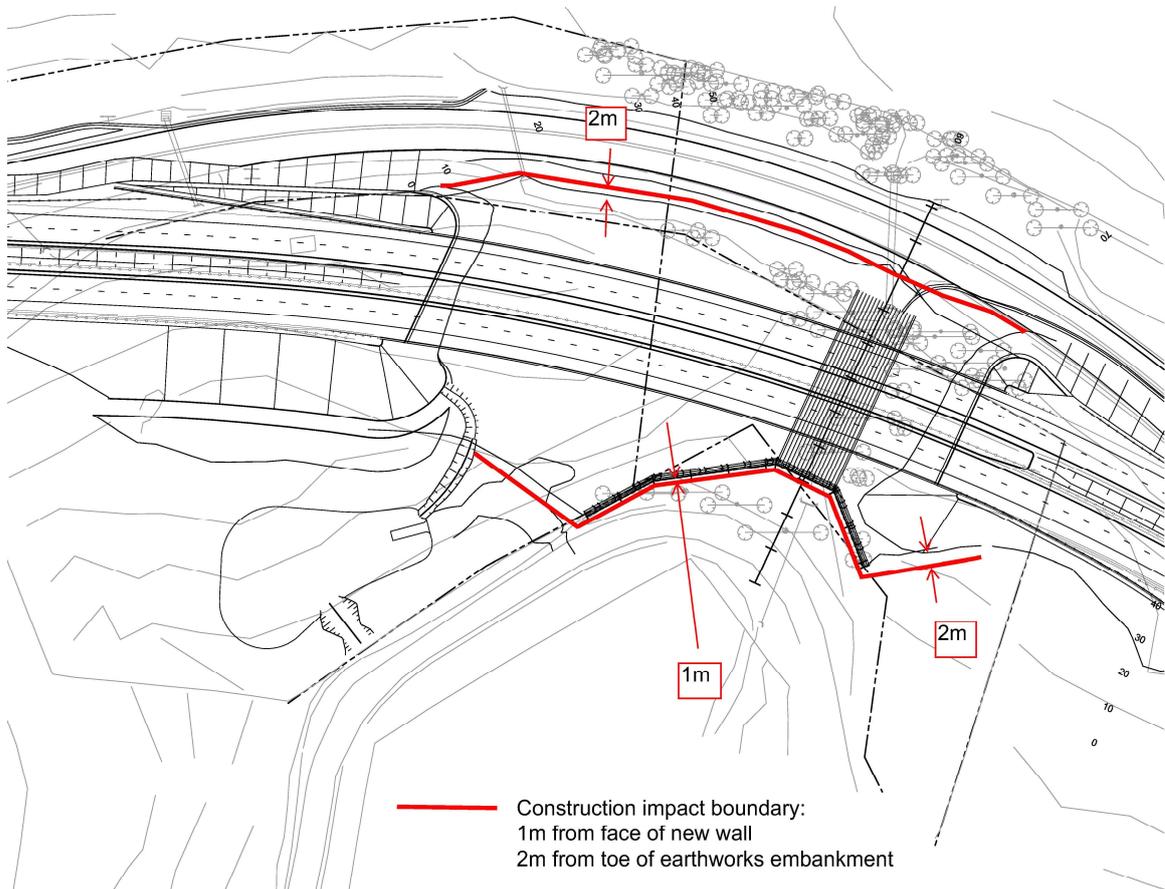


Figure 3: Cross-section of revised proposal.



**FORTY BENDS  
 BOUNDARIES**

**INFORMATION DOCUMENT**  
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Figure 4: Location of proposed arch in relation to the road reserve. It is likely that the proposed 7.5m high arch will dominate the location of the 1830s culvert. It also likely to involve removal of trees on Forty Bends Road.

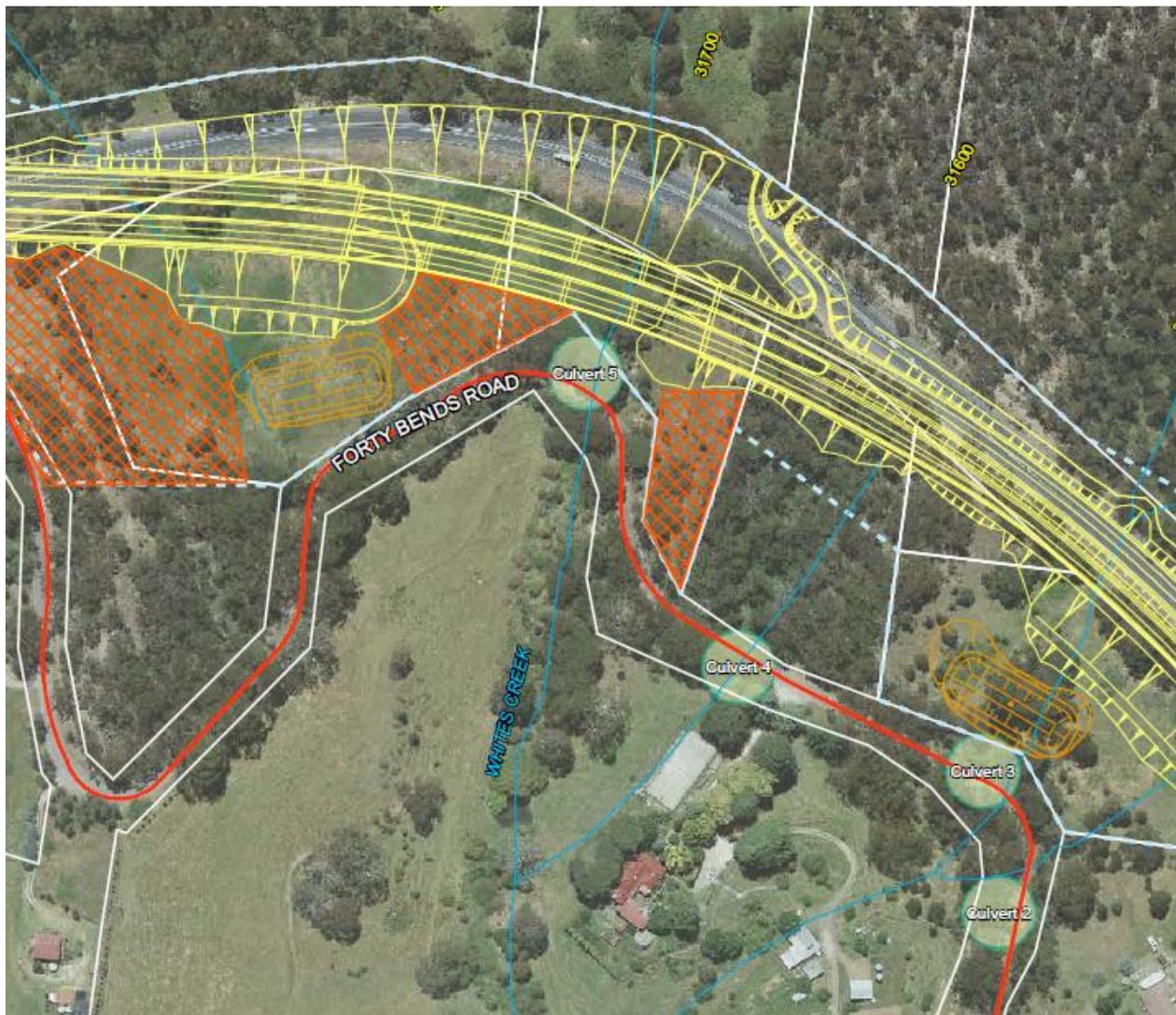


Figure 5: Location of Culvert 5 in relation to the determined REF boundary. Compare with Figure 4 in relation to the footprint of impacts from the two proposals.

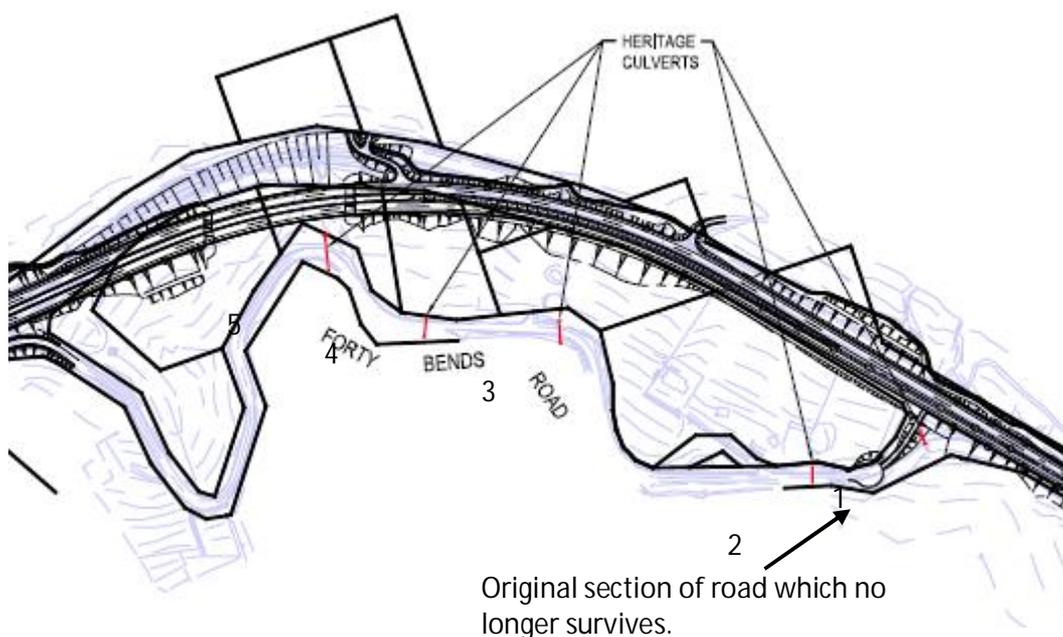


Figure 6: Survey plan of Forty Bends Road, Culverts 1 to 5, and the determined proposal.



Figure 7: View westwards from Bend 4 to Bend 5 with another rock cutting on the northeast, approaching Whites Creek. C&L 2012



Figure 8: Western side of cutting in Figure 7, looking southeast. C&L 2012



Figure 9: Sandstone block retaining wall of Culvert 5, northern or upslope face. C&L 2009



Figure 10: Southern side of Culvert 5 is a modern concrete culvert. C&L 2011



Figure 11: View along Forty Bends Road approaching Whites Creek and Culvert 5. Note the substantial cutting.



Figure 12: View to northwest in the general location of Culvert 5 with the Great Western Highway in the middle ground.



Figure 13: View to northeast in general location of Whites Creek and the revised proposal. In the revised proposal a 14m high embankment would dominate this 'country lane' landscape where it crosses through the grassy paddock.

# Appendix D

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## Landscape Character and Visual Impact Assessment

# GREAT WESTERN HIGHWAY UPGRADE MOUNT VICTORIA TO LITHGOW FORTY BENDS UPGRADE

## **Review of Environmental Factors Technical Paper 7 Landscape Character & Visual Impact Assessment**

ADDENDUM 01

OCTOBER 2014



**SPACKMAN  
MOSSOP  
AND  
MICHAELS**



**Transport**  
Roads & Maritime  
Services

# Great Western Highway Upgrade Mount Victoria to Lithgow Alliance Forty Bends Upgrade

## Review of Environmental Factors Technical Paper 7 Landscape Character & Visual Impact Assessment

ADDENDUM 01

OCTOBER 2014

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| Version | Status                    | Date       | Released by |
|---------|---------------------------|------------|-------------|
| 01      | Draft for Alliance Review | 04.09.2014 | MW          |
| 02      | Final Issue for Review    | 15.09.2014 | MW          |
| 03      | Final Issue               | 14.10.2014 | MW          |
|         |                           |            |             |
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## 1. INTRODUCTION

This addendum to the Landscape Character and Visual Impact Assessment Report comments on the effects, in terms of landscape character and visual impact assessment, of the proposed changes to the Concept Design as presented in the Review of Environmental Factors (REF) for the proposed upgrading of Great Western Highway at Forty Bends. The changes to be addressed in this report are described below.

## 2. DESCRIPTION OF CHANGES

The existing design within the issued REF included new twin, five-span bridges, about 150 metres in length across Whites Creek. The new bridges would comprise four lanes, each 3.5 metres in width, with two lanes carrying traffic in each direction. The total width of the two bridges would be about 30 metres. Shoulders on the bridges would be between 2.5 and 3.25 metres (off-side) and 1.0 metres on the near side.

Following the display of the REF, detailed design of the Forty Bends upgrade was undertaken, taking into consideration community and stakeholder feedback, additional value engineering and additional environmental investigations. As part of the detailed design, an alternative to the twin bridge over Whites Creek was investigated. This includes the replacement of the current five span bridge design over White Creek with a precast concrete arch on piled footings with earth fill embankment and reinforced earth walls.

The proposed alternative bridge design includes:

- A precast arch 17m wide and 7.5m high. Piled footings have been chosen to limit the differential settlement across the arch to within 5mm, with the foundations consisting of bored piles of rock with a reinforced concrete capping beam
- Reinforced earth walls around the lower perimeter of the embankment, particularly around the property boundary to the south of the site. The extent of these walls has been assessed and heights up to 14m have been determined
- Batter slopes of 2:1 above the wall and 3:1 below the wall
- Scour protection in front of the foundations to protect the arch from any undermining during a flood event.

This assessment has been based on the limited information provided and it has been necessary to make a number of design assumptions. Information provided has included a plan and elevation, photographic examples and limited descriptive text. The assessment has assumed that the embankment slopes would be fully revegetated with indigenous trees, shrubs and groundcovers, and that the median would also be vegetated with shrubs and groundcovers. If these assumptions are not achieved by the contractor, the assessment ratings would be higher.

Figure 2.1 shows an example of a precast arch with reinforced earth walls and Figure 2.2 and Figure 2.3 present sketch designs of the proposed alternative bridge design.

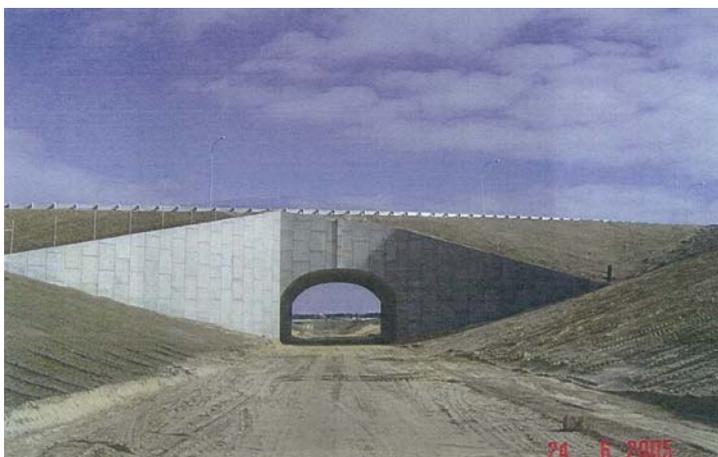


Figure 2.1: Example of proposed precast arch bridge (source: Seymour Whyte)



Figure 2.2: Plan of the proposed alternative concrete arch bridge (source: SMEC)



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**FORTY BENDS**  
**BOUNDARIES**

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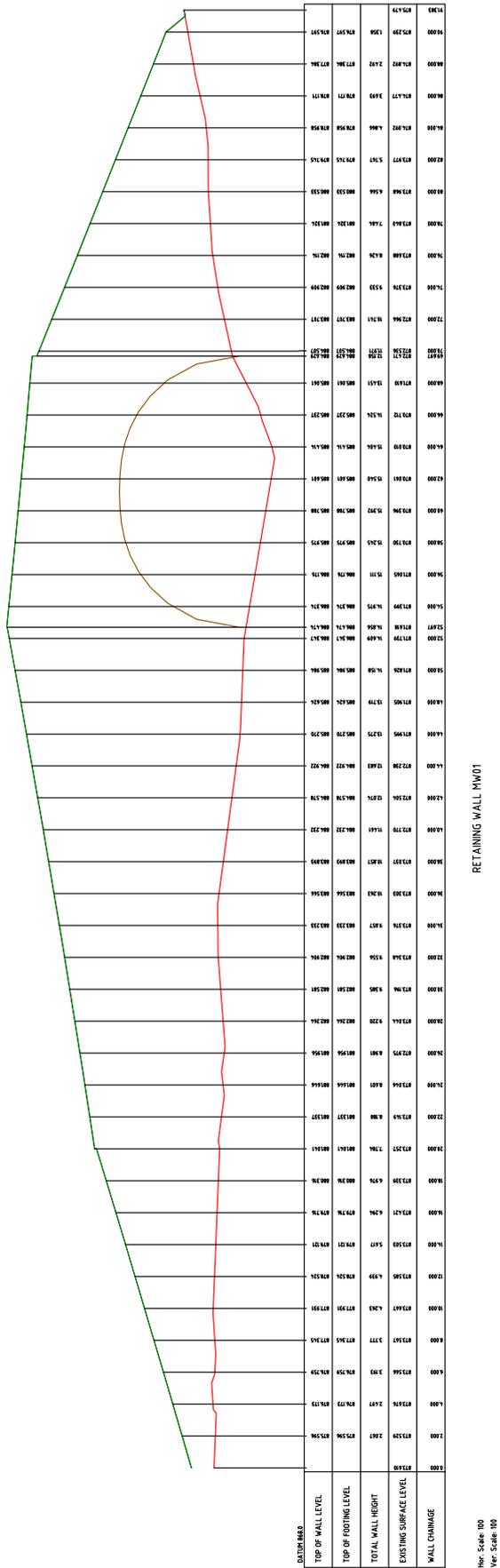


Figure 2.3: Elevation of the proposed alternative concrete arch bridge (source: SMEC)

### **3. EFFECTS OF THE CHANGES**

The proposed design changes described previously would affect one of the landscape character zone (LCZ) and four viewpoints previously assessed in the Landscape Character and Visual Impact Assessment Report, presented as part of the REF. The numbers of the affected LCZ and viewpoints are highlighted in red on Figure 3.1 and Figure 3.2 and described in more detail below.

#### **3.1 LANDSCAPE CHARACTER IMPACT**

For the previous assessment, the study area was divided into three LCZ's, corresponding to landscape character types in the area and allowing for a more detailed discussion of the character of each zone. Each zone was then broken down into a number of different character attributes which were described in their existing situation, and as they would be as a result of the project. The magnitude of the proposed works, and the sensitivity of the LCZ to change were then assessed to determine the overall landscape character impact.

The proposed changes to the design would have an affect on LCZ 2:Whites Creek Valley. These changes are described below.

##### **3.1.1 LCZ 2: Whites Creek Valley**

The assessment indicates that the proposed design changes would affect the following character attributes within LCZ 2.

##### **Topography**

The proposed alternative bridge would require extensive fill embankments and retaining walls up to 14 metres high. This would greatly alter the existing topography by providing an additional built vertical element into the predominately undulating pasture lands south of the existing highway.

##### **Hydrology**

The existing flow of Whites Creek, the main watercourse and part of Sydney's drinking water catchment, should not be affected. A 51 metre section of the existing creek would be enclosed by the proposed alternative bridge.

##### **Vegetation**

It is estimated that at least six additional mature native trees would be required to be removed along the northern edge of Forty Bends Road for the construction of the proposed alternative bridge. The increased extent of the proposed embankments would allow additional tree planting to occur. Additional tree planting in front of the reinforced earth walls would slightly reduce their impact as the trees mature over time.

##### **Spatial Quality**

The proposed alternative bridge and associated reinforced earth walls and embankments would greatly increase the sense of enclosure from Forty Bends Road, compared to the original REF proposal. Views to the south over the rolling rural landscape would be maintained.

##### **Landscape Character Assessment**

The Whites Creek Valley LCZ was previously assessed to have Moderate sensitivity and a High magnitude, resulting in a High to Moderate landscape character impact. The proposed design changes would not change the sensitivity rating, which would remain Moderate. The proposed changes would maintain the same amount of road pavement as previously assessed. The proposed alternative bridge would reduce the size of road infrastructure and would be more in scale with the existing landscape. However, the extent of the embankments would be greater than the previous design, although new tree and shrub planting on these would, over time, integrate the embankments with the vegetated slopes of Hassans Walls. However, the 14 metre high reinforced earth walls around the arch would be out of character with the existing landscape character and would require the removal of additional native trees, particularly along the boundary of Forty Bends Road, and

the initial impact following construction would be high. The close proximity of the proposed reinforced earth wall to Forty Bends Road will restrict the potential for any tree and shrub planting between the wall and the road, exposing the wall to motorists which will have a highly adverse visual impact in this LCZ. The proposed changes would therefore retain the High magnitude rating. Therefore, the overall landscape character impact would remain High to Moderate.

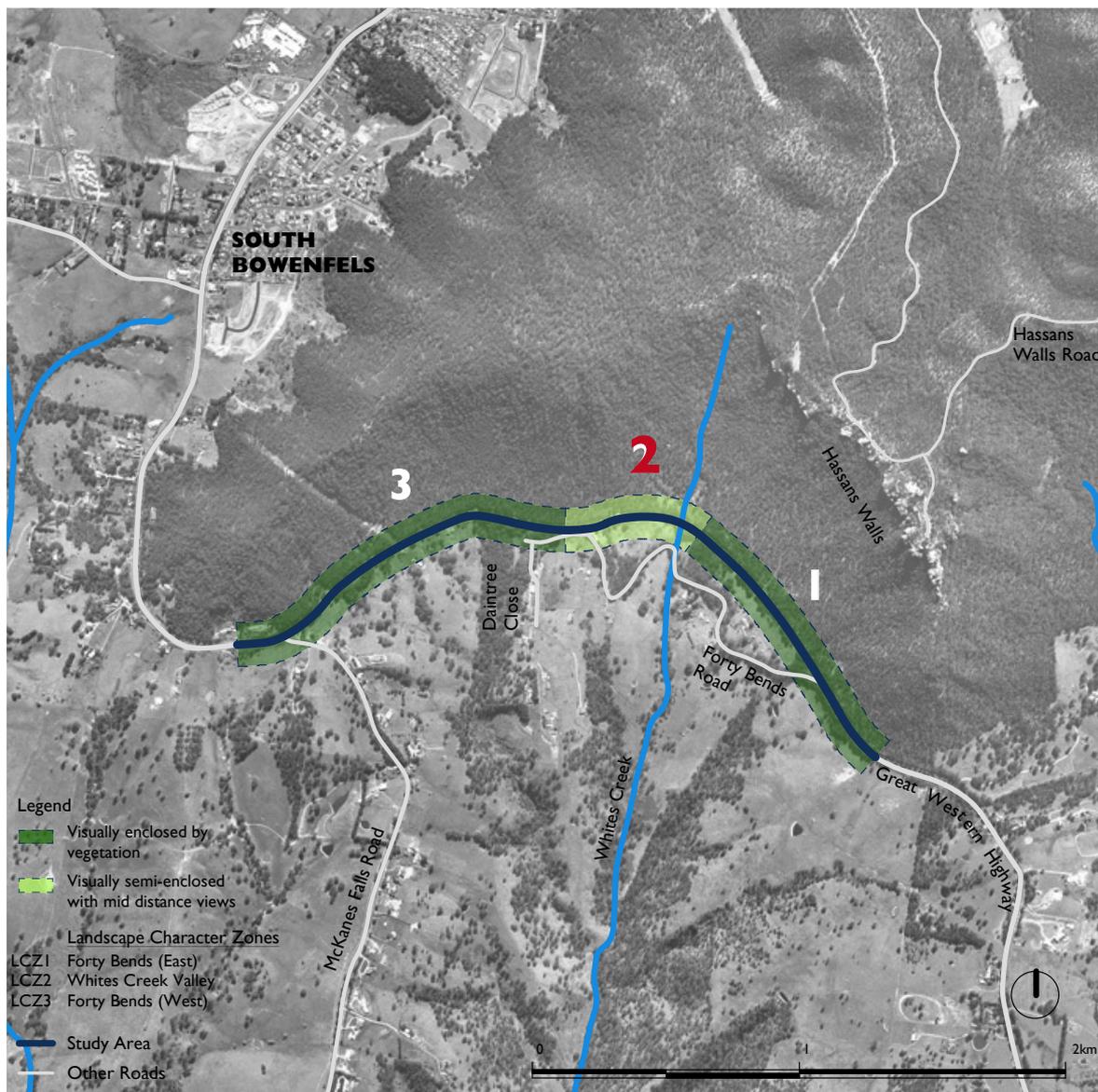


Figure 3.1: Landscape Character Zones, showing the affected zone, LCZ 2, in red

## 3.2 VISUAL IMPACT

The previous study assessed the potential visual impact of the project in relation to twelve identified key viewpoints within an estimated visual catchment. A desktop assessment suggests that the proposed changes would affect four of these viewpoints. These are shown in red in Figure 3.2 and include:

- Viewpoint 1
- Viewpoint 4
- Viewpoint 5
- Viewpoint 6.

### 3.2.1 Viewpoint 1

Location: Long distance view from the edge of Hassans Walls Lookout, looking west.

Description: The edge of the rock escarpment, south of the Hassans Walls Lookout is a popular public lookout that provides spectacular 270° panoramic views over the dramatic natural and rural landscape of the area. The extent of the site is only a small section of the panorama. The edge of the vegetation that delineates the road corridor is clearly seen from this location.

#### Visual Impact Assessment

Viewpoint 1 was previously assessed to have High to Moderate sensitivity and a High to Moderate magnitude, giving a High to Moderate visual impact. The proposed works would not change the sensitivity rating, which would remain High to Moderate. The changes when viewed from this location and angle, would allow for the opportunity for vegetated embankments and planting in the medians. The reinforced earth wall around the northern end of the arch would be visible from this location, however planted vegetation around this wall would reduce its visibility over time. The construction of the southern reinforced earth wall would require the removal of at least an additional six mature trees along Forty Bends Road. The initial magnitude impact following construction would be high, however, it would reduce to High to Moderate as the vegetation mature over time. Therefore, the visual impact rating would remain at High to Moderate.



### 3.2.2 Viewpoint 4

Location: Foreground view from Great Western Highway, station 31630, looking west.

Description: Within the road corridor, the landscape slopes to the gentle gully of Whites Creek. Good quality Blaxland's Stringybark - Mountain Gum Open Forest is located to the south and Silvertop Ash Open Forest to the north on the slopes of the Hassans Walls escarpment, providing an attractive rural road character, with dappled light and shade and filtered views to the rural landscape to the south. A concrete barrier divides the carriageways.

#### Visual Impact Assessment

Viewpoint 4 was previously assessed to have Moderate to Low sensitivity and a High magnitude, giving a High to Moderate visual impact. The proposed works would not change the sensitivity rating, which would remain Moderate to Low. The extent of road pavement, road alignment and amount of tree removal would remain the same, however, the median would now be planted. The proposed embankment planting would provide a sense of enclosure to the highway as they mature over time, however, the magnitude rating would remain High. Therefore the visual impact rating would remain High to Moderate.



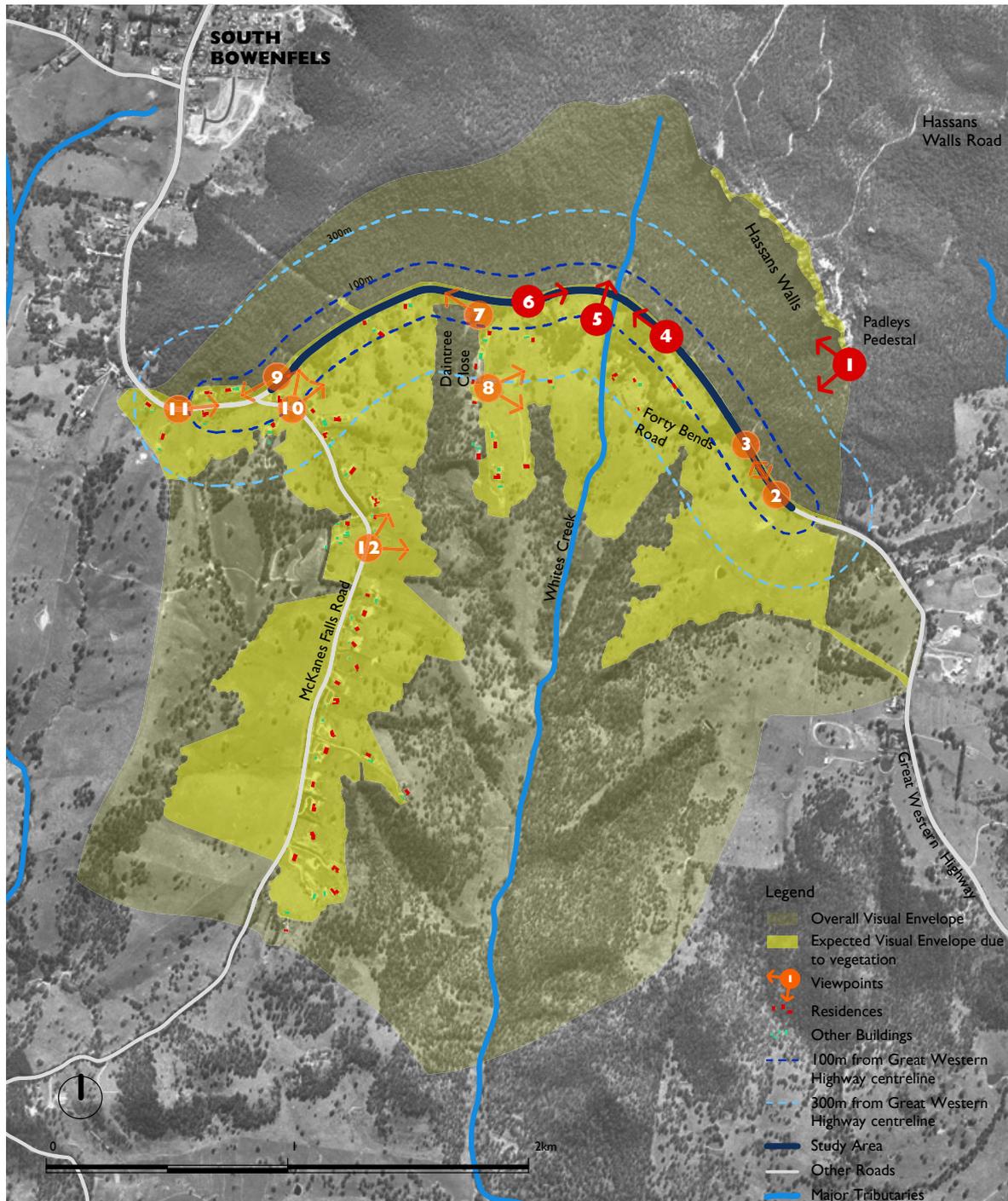


Figure 3.2: The Visual Envelope Map (VEM) with affected viewpoints shown in red.

### 3.2.3 Viewpoint 5

Location: Foreground view from Forty Bends Road, west of Whites Creek, looking north.

Description: Gently sloping pasture land and rural fencing with scattered tree planting adjacent to Forty Bends Road. Forty Bends Road is an attractive, tree lined, winding rural road with open and forested views. Forty Bends Road also has high heritage values being associated with Major Thomas Mitchell's original road, surveyed and built in the 1830's.

#### Visual Impact Assessment

Viewpoint 5 was previously assessed to have Moderate sensitivity and a High magnitude, giving a High to Moderate visual impact. The proposed works would not change the sensitivity rating, which would remain Moderate. The reinforced earth walls for the proposed alternative bridge would require the removal of at least six additional mature native trees along Forty Bends Road, and the walls and arch would be highly visible to motorists travelling along this section of Forty Bends Road. The extent of the embankments would be greater than the previous design, however; new tree and shrub planting to these would integrate the embankments with the vegetated slopes of Hassans Walls from this view over time.



The choice of recessive material colours would potentially reduce the visibility of the reinforced earth walls and concrete arch, however; they would remain highly visible due to the removal of existing mature trees, and due to its immediate proximity to the edge of Forty Bends Road and the lack of space for screen planting. Therefore the magnitude of the proposed works would remain High, and the visual impact rating would therefore remain to High to Moderate.

### 3.2.4 Viewpoint 6

Location: Foreground view from Great Western Highway at intersection of Forty Bends Road, looking east.

Description: Within the road corridor, the landscape slopes down to Whites Creek, and is surrounded by Blaxland's Stringybark - Mountain Gum Open Forest on the slopes to the north and mixed native vegetation community to the south. An existing exposed cutting is located to the northern side of the road. There are attractive mid distance views to Hassans Walls.

#### Visual Impact Assessment

Viewpoint 6 was previously assessed to have Moderate to Low sensitivity and a Moderate magnitude, giving a Moderate visual impact. The proposed works would not change the sensitivity rating, which would remain Moderate to Low. The extent of road pavement, road alignment and amount of tree removal would remain the same. The proposed embankment planting would provide a sense of enclosure to the highway as they mature over time, however; the magnitude rating would remain Moderate. Therefore the visual impact rating would remain Moderate.



### 3.2.5 Summary

The visual impact assessment of the proposal presented in the REF indicated a range of ratings from High to Moderate impact through to Moderate impact. Of the four viewpoints assessed as part of this addendum, three previously had High to Moderate visual impact and one had Moderate visual impact. Overall, the changes to the works would have a greater adverse effect on two of the viewpoints, although as the magnitude ratings were already high, there is no change to the overall visual impact rating.

## 4. MITIGATION

During the Concept Design stage of the project, to lessen the visual impact of the proposal and to help integrate the Whites Creek bridge into the landscape, a number of mitigation measures were incorporated into the design. They included:

- Retaining roadside vegetation where possible
- Revegetation, based on existing vegetation communities (including grasses, groundcovers, shrubs, riparian species, and trees depending on sight line requirements), in medians and roadside areas to help reduce perceived corridor width
- The design of the new bridge over Whites Creek and associated earthworks should be designed to minimise impacts on the creek bed, banks and vegetation
- Minimise the depth of the structure to reduce the visual impact of the bridge from surrounding areas. The number of bridge piers should be minimised to keep views through and across the bridge as open as possible. The tapering of the piers would give them a finer appearance.

The detailed design of the alternative bridge proposal must have an integrated engineering, urban design, heritage and biodiversity outcome. This design must minimise the visual impact of hard elements associated with the size and extent of the retaining wall, earth embankment and culvert structure, and maximise the opportunities for tree and shrub planting. The design of the revised proposal will need to address the following:

- Revise the current design to relocate the reinforced earth wall away from Forty Bends Road to avoid impacting the existing trees along the road corridor
- Protect the primary root zones of existing roadside trees, particularly those along Forty Bends Road
- Commission an arborist to work with the design team to ensure that appropriate protection measures are put in place for the existing trees along Forty Bends Road
- Consider sloping the underpass portal opening to match the gradient of the slope and revegetate the surrounding embankment (refer to Figure 4.1)
- Consider reducing the height and scale of the reinforced earth walls by terracing, and/or changing the angle of the wingwalls. The implementation of this measure may be dependent on liaison with adjoining landowners
- Detailed design must integrate the earth embankments into the adjoining landform to minimise their visual appearance
- Maximise revegetation of new embankments to visually integrate them with the vegetated slopes of Hassans Walls
- Continue shrub and groundcover planting to the median over the proposed pre-cast concrete arch and embankment structure to reduce the extent of hard surface and to help reduce perceived corridor width
- Use visually recessive materials, textures and colours, such as black oxide or pre-cast concrete panels with exposed basalt aggregate finish to the reinforced earth walls and pre-cast concrete arch structure (refer to Figure 4.2)
- Provide additional planting in verge between the reinforced earth walls and Forty Bends Road to provide screening of the wall to motorists travelling along Forty Bends Road
- Place large boulders in a random formation in front of the foundations (whilst considering the ecological requirements outlined in BI-I 6) to reduce scour; using rock excavated from the site, otherwise use a grey basalt rock.



Figure 4.1: Example of a sloped portal entrance



Figure 4.2: Example of a basalt aggregate finish to reinforced earth wall



## 5. CONCLUSION

The changes to the Concept Design, including the replacement of the five span bridge over Whites Creek with a precast concrete arch on piled footings with earth fill embankments and reinforced earth walls, would have greater impact to the landscape character and visual impact to those already described in the REF. The proposed alternative bridge would be a reduction in size and scale than that previously assessed, however the reinforced earth walls would be out of character with the area and would be highly visible when viewed from Forty Bends Road.

The loss of at least six mature trees plus a number of smaller trees along the northern edge of Forty Bends Road would create a highly adverse visual impact on this section of this historic road. The limited potential for any screen planting in front of the wall in its current location, adjacent to the road, would result in this adverse visual impact remaining into the long term. However this adverse impact could be substantially reduced if the arch and the reinforced earth walls were relocated away from the edge of Forty Bends Road and if this resulted in the long term protection of the existing roadside vegetation.

The successful establishment of consistent vegetation cover over the embankments adjacent to the arch and the wing walls have the potential to better integrate this alternate bridge proposal with the adjoining landscape and the backdrop of Hassans Walls as the planting matures over time.

The assessment indicated that the rating of the one affected LCZ would remain High to Moderate. Three of the four viewpoints would be slightly affected, although not enough to change the overall visual impact rating. The remaining Viewpoint 5 rating would also remain unchanged despite the magnitude being greater, as the magnitude rating assessed in the REF was already High.

The assessment has been based on the limited information available to undertake this assessment, and relies entirely on the assumptions made in Chapter 2 and the incorporation of the proposed mitigation measures in the future design of the work. If any of these assumptions and/or mitigation measures can't be achieved, then the impact ratings would be higher.





# Appendix E

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Neutral or beneficial effect on water  
quality assessment

## Neutral or Beneficial Effect Assessment

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*State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* relates to the use of land within the Sydney drinking water catchment. In accordance with Clause 12 of the SEPP, Roads and Maritime Services is required to consider whether or not an activity to which Part 5 of the *Environmental Planning and Assessment Act* applies will have a neutral or beneficial effect on water quality before carrying out the activity.

The alternative pre-cast concrete arch structure design has been assessed against the determined Neutral or Beneficial Effect (NorBE) Assessment undertaken as part of the determined REF (Roads and Maritime, 2012a). The revised design is considered to be consistent with the findings and conclusions of the previous NorBE assessment which concluded that the project would result in a neutral effect on water quality due to the proposed water quality mitigation measures (such as water quality basins) which were proposed as part of the determined REF.

# About this document

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## Approval and authorisation

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| Approved by | Principal Manager Environmental Policy, Planning & Assessment                  |

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|---------|----------|---|
| 1.0     | 03/10/08 | First issue   |
| 1.1     | 12/12/08 | Executive summary outline revised   |
| 2.0     | 30/06/10 | EIA-P05-2 changes, general best practice updates  |
| 2.1     | 25/01/11 | Addition of clause 228(2)(p)  |
| 3.0     | 09/09/11 | Incorporation of trial version comments. Legal review complete. Third issue.  |
| 3.1     | 13/07/12 | Addition of Growth Centres SEPP consultation  |
| 3.2     | 10/07/13 | Minor amendments to safeguards table & section 4.1  |
| 3.3     | 15/07/13 | Update to Commonwealth Minister portfolio   |
| 3.4     | 21/08/14 | Updated titles, roles, responsibilities and processes following internal restructure. Update to logo and report template. Update to State and Australian Government department titles. Document made web accessible (WCAG). Change to document location (G drive to Objective). |

Your comments and suggestions to improve this or any of the EIA guidelines may be sent to:

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