7 Development of route options

7.1 Assessment criteria and methodology

The identification of a shortlist of route options which best meet the objectives of the project was undertaken using the generally recognised route options development process (see **Section 1.5**). **Table 7-1** sets out the broad project measurable / selection criteria based on the project objectives.

At the stage of assessment of preliminary route options, some of the studies relevant to the *Critical Criteria* listed in **Table 7.1** had yet to be carried out and therefore some of the *Critical Criteria* could not be assessed.

As the project progressed, additional studies were carried out that allowed the majority of the *Critical Criteria* to be assessed.

Table 7-1 Project measurable / selection criteria for assessment of preliminary route options

Project Objectives	Critical Criteria*[1]	Description of criteria that can be assessed
Improve road safety	• Reduced crash rate and injuries • Improved road safety standards – improved geometry standard • Minimise conflict points on the highway (intersections) • Constructability • Work health and safety in construction and maintenance.	• Provide for an overtaking lane for southbound traffic and possibly a dual lane carriageway separated by wire rope. • Provide an alignment that minimises problems in construction. • Maintain at least one lane of the highway open during construction of the upgrade. • Minimise work health and safety risk in construction and maintenance.
Improve road transport productivity efficiency and reliability of travel	• Reduced road freight user costs • Reduced travel time • Target a route level of service of A • Increase road network capacity.	• Provide appropriate horizontal and vertical road geometry.
Minimise the impact on the natural, cultural and built environment	• Impact on fauna habitat including threatened species • Impact on flora including threatened species • Water quality • Air quality • Noise and vibration impact • Aboriginal and Non-Aboriginal heritage • Stormwater and drainage • Residential and commercial properties impacted • Ecological sustainability • Visual impact and amenity.	• Minimise adverse impacts on native vegetation. • Minimise adverse impacts on sensitive habitats. • Minimise adverse impacts on Endangered Ecological Communities. • Minimise adverse impacts on surface water quality. • Minimise adverse impacts on flooding and drainage. • Minimise adverse impacts on known non-Aboriginal heritage sites, values and areas of archaeological potential. • Minimise adverse impacts on known Aboriginal heritage sites, values and areas of archaeological potential. • Potential to use recycled or waste materials.

Project Objectives	Critical Criteria*[1]	Description of criteria that can be assessed
Provide value for money	• Cost benefit ratios • Net Present Value over 30 years • Road user costs and benefits • Infrastructure operating costs (including maintenance) • Comparative project costs.	• Minimise project cost.

Note *1 – Feasible routes must conform to critical criteria

The route options development process involved:

- Identification of physical, environmental and social constraints
- Qualitative assessment of a number of potentially feasible route options
- Rejection of any options which are fundamentally flawed
- Comparison of the performance of the remaining options against a set of criteria related to the project objectives
- Identification of the best performing options.

The development of the route options from a long to a shortlist is based on a qualitative assessment of the relative impacts of each one. A qualitative assessment of the routes determines whether one thing is larger, smaller or equal to another, without specifying the size of any difference. A quantitative assessment of the routes determines the amount or size of each aspect of the route being assessed and specifies the size of the difference.

The shortlisting process of route options for this project followed four phases:

- Determination of a list of options (refer **Section 7.2**)
- Initial assessments (refer **Section 7.3**)
- Internal Technical Workshop (refer **Section 7.4**)
- Conclusion and next steps (refer **Section 7.5**).

7.2 Phase 1: Determination of a list of options

7.2.1 Routes identified by the project team

Routes were identified by the project team and included in the “list” of routes that were then assessed. **Figure 7-1** presents the list of routes (11 alternate routes) that were carried forward into the second and third phases of the selection process.

Sections 7.2.2 to **7.2.12** provide descriptions of the options developed by the project team.

Section 7.2.13 describes options suggested by the community.

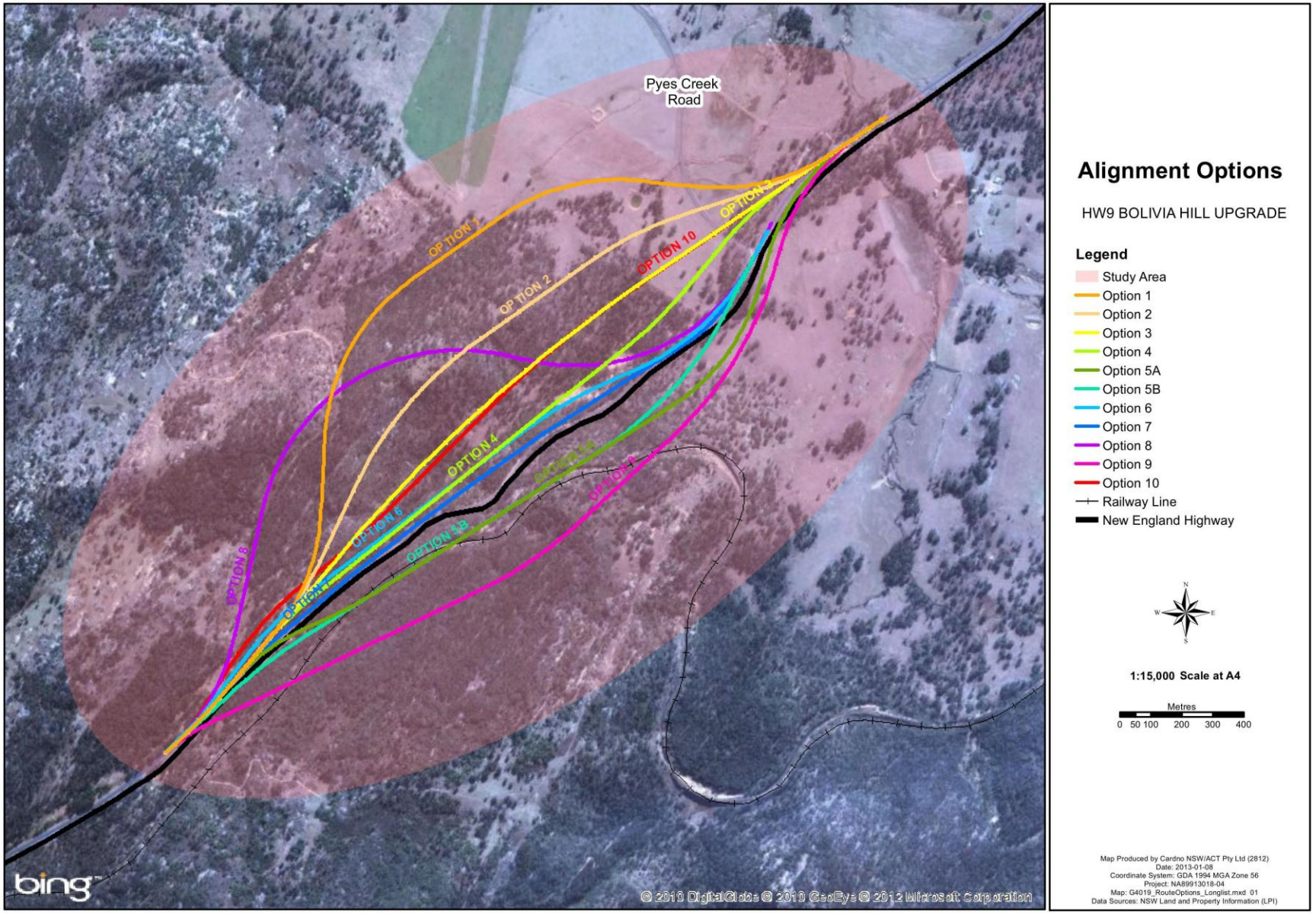


Figure 7-1 List of route options

7.2.2 Option 1

Option 1 attempts, in part, to follow the former Cobb & Co road to the west of the existing alignment to reduce property acquisition by using an existing road reserve where possible.

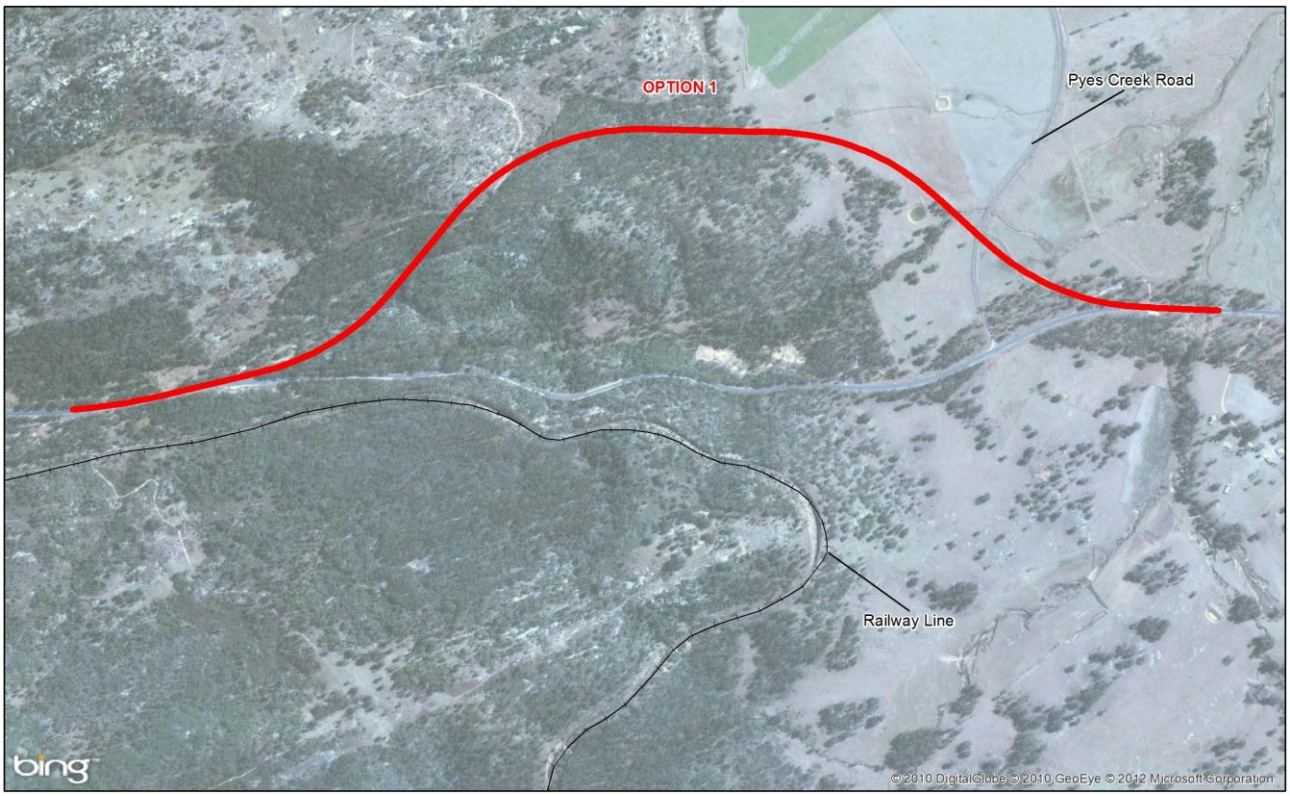


Figure 7-2 **Option 1**

The key features of this option are:

- Option 1 is 3450 metres long
- Deep cuts and high fills are required to achieve a maximum conforming vertical grade of 6 per cent
- The first 1000 metres (from the southern project boundary) consists of minor cut and fill plus a bridge 130 metres long over the watercourse in the gully to the west of the existing highway
- The alignment moves into a major cut through the ridge at the western extent of the study area. The cut is 700-800 metres long and up to 65 metres deep. A tunnel option (450 metres in length) through this section was assessed at a later stage for cost and constructability comparison
- The alignment then moves into extensive fill up to 15 metres high as it grades down to the Brickyard Creek floodplain. Extensive retaining walls may be required. A bridge up to 150 metres long will be required across the watercourse to the west of the existing highway just south of Pyes Creek Road
- To the north of the bridge the alignment is in minor fill with the last 200 metres being an upgrade of the existing highway
- Estimated cost $584 million.

7.2.3 Option 2

Option 2 is similar to Option 1 but with an attempt to reduce both the amount of hard rock excavation required and the overall route length.

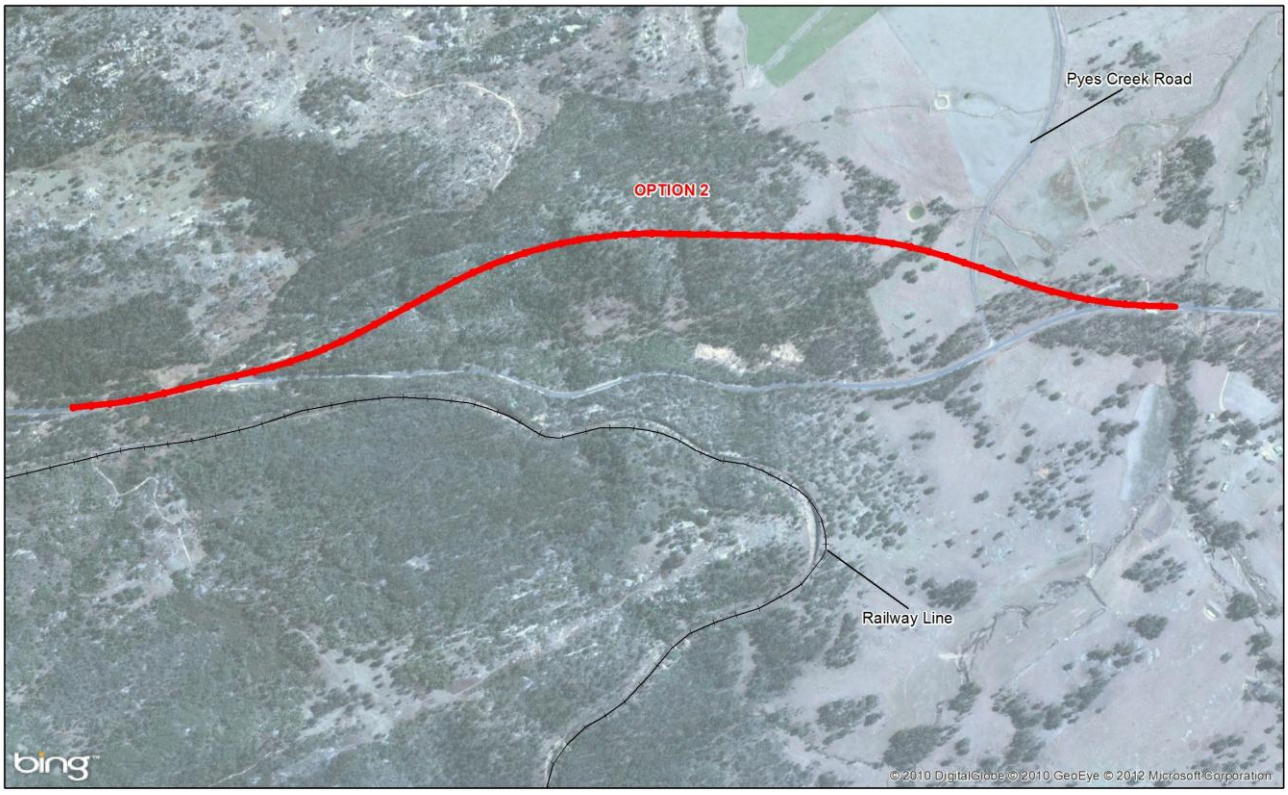


Figure 7-3 **Option 2**

The key features of this option are:

- Option 2 is 3200 metres long
- Deep cuts and high fills are required to achieve a maximum conforming vertical grade of 6 per cent
- The first 1050 metres (from the southern project boundary) consists of minor cut and fill plus a bridge 150 metres long over the watercourse in the gully to the west of the existing highway
- The alignment moves into a major cut through the ridge at the western extent of the study area. The cut is 600 metres long and up to 25 metres deep. The majority of the cut is on the western side of the alignment into the ridgeline
- The alignment then moves into extensive fill up to 20 metres high as it grades down to the Brickyard Creek floodplain. Extensive retaining walls and or bridges may be required. A bridge up to 200 metres long will be required across the watercourse to the west of the existing highway just south of Pyes Creek Road
- The high fill continues over Pyes Creek Road and grades down with the last 200 metres being an upgrade of the existing highway
- Estimated cost $316 million.

7.2.4 Option 3

Option 3 achieves the best geometric outcomes of all the routes identified as it is the most direct with minimal horizontal direction change; however this option requires a major bridge/viaduct.

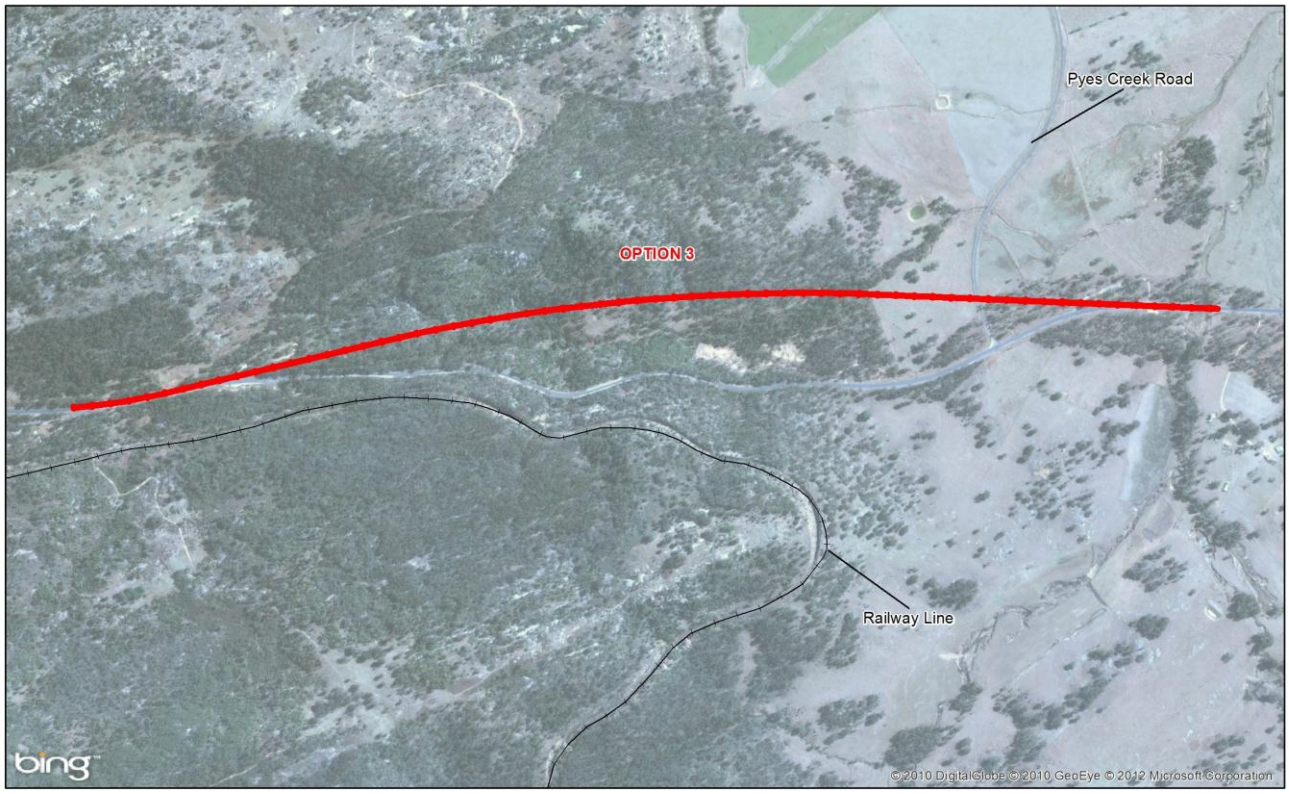


Figure 7-4 **Option 3**

The key features of this option are:

- Option 3 is 3120 metres long
- The option has a maximum conforming vertical grade of 6 per cent
- The first 750 metres (from the southern project boundary) consists of minor cut and fill
- The alignment crosses the watercourse in the gully to the west of the existing highway then follows the line of the gully to the west of the waterway. A major bridge/viaduct up to 1500 metres long is required to keep the roadway out of the creek line
- The viaduct ends before Pyes Creek Road. High fill then grades down with the last 200 metres, being an upgrade of the existing highway
- Estimated cost $445 million.

7.2.5 Option 4

Option 4 aims to keep the alignment as close the existing highway alignment as possible while achieving conforming horizontal and vertical alignments.

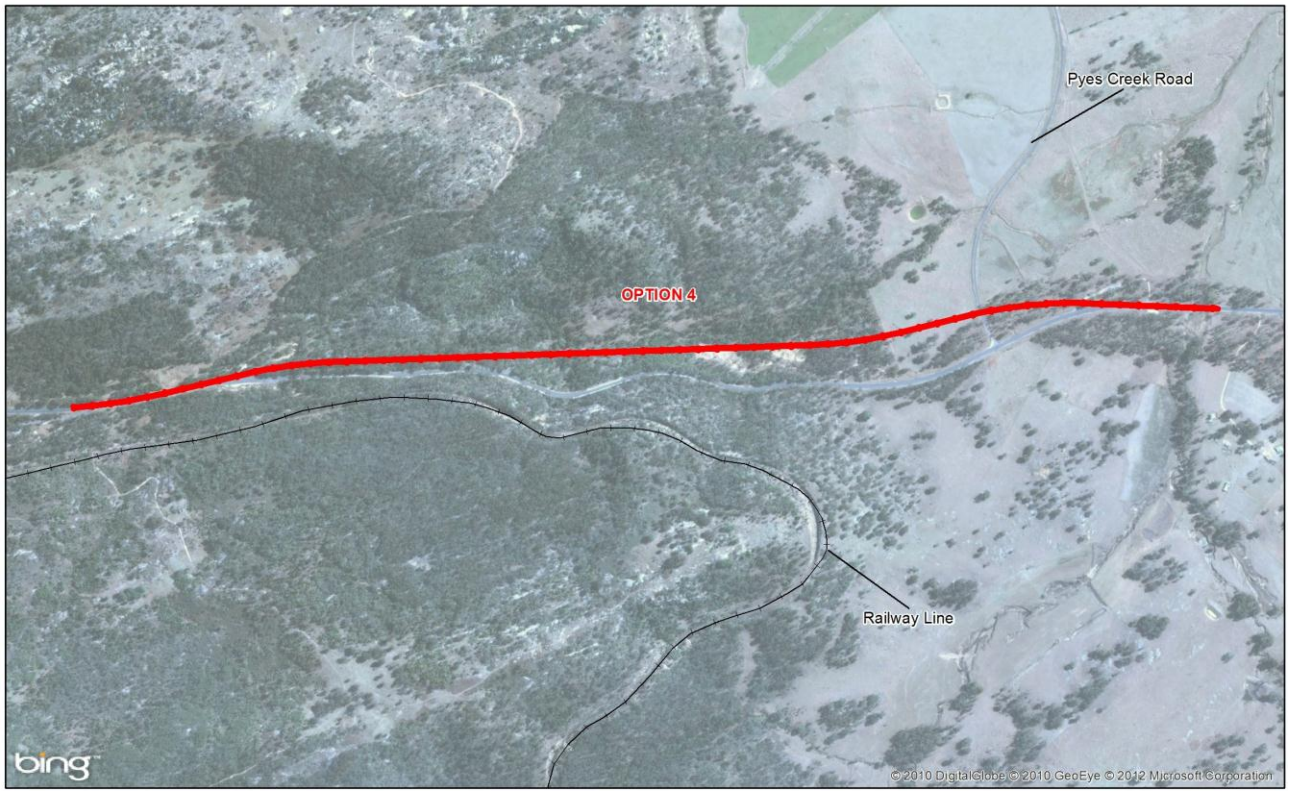


Figure 7-5 **Option 4**

The key features of this option are:

- Option 4 is 3100 metres long
- The option has a maximum conforming vertical grade of 6 per cent
- The first 800 metres (from the southern project boundary) consists of minor cut and fill
- The next 200 metres requires extensive fill up to 20 metres high, possibly requiring extensive retaining walls
- The alignment then follows the line of the gully to the west of the highway on the eastern side of the waterway. A major bridge/viaduct up to 1000 metres long is required to keep the roadway out of the creek line
- The viaduct ends before Pyes Creek Road. High fill then grades down with the last 200 metres being an upgrade of the existing highway
- Estimated cost $430 million.

7.2.6 Option 5a

Option 5a is an eastern option that requires a tunnel underneath Bolivia Hill Nature Reserve that would ensure no disturbance to the nature reserve and the Main Northern Railway line.

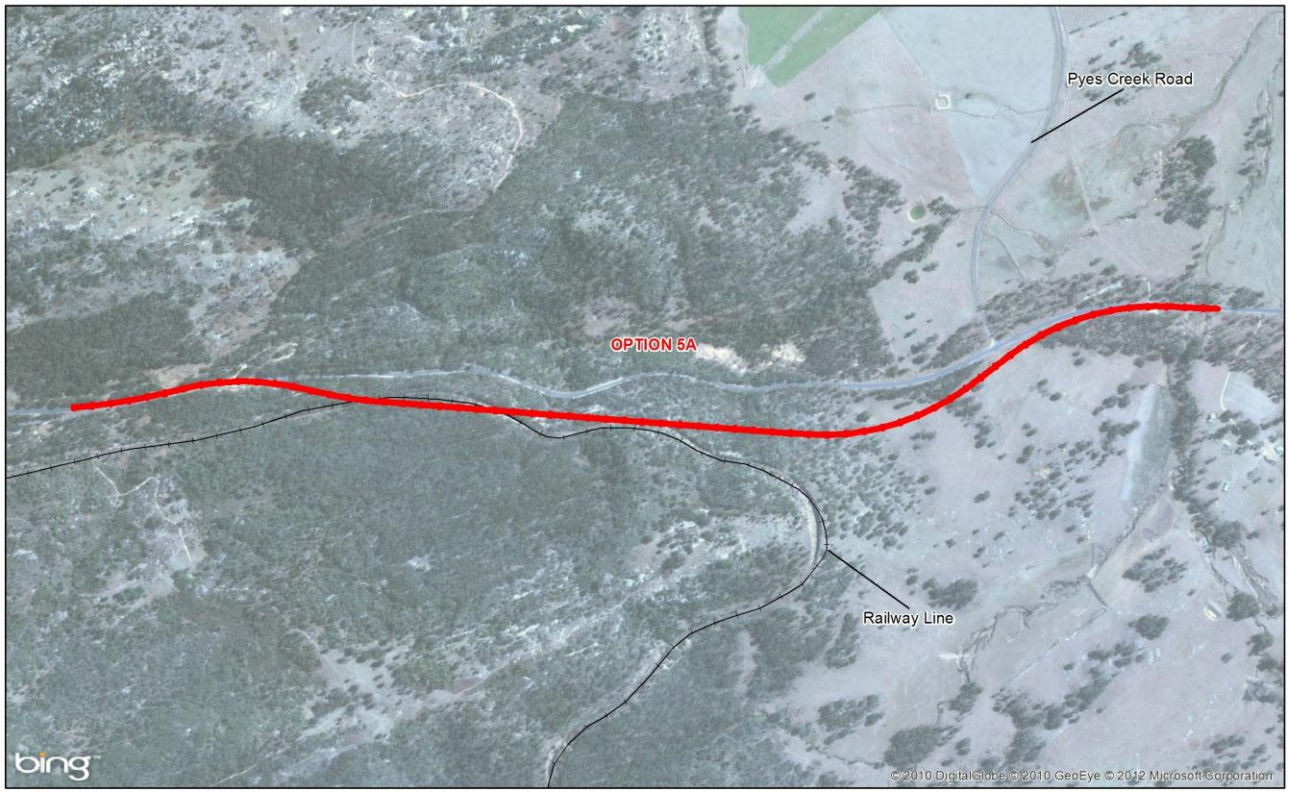


Figure 7-6 **Option 5a**

The key features of this option are:

- Option 5a is 3200 metres long
- To achieve the maximum conforming vertical grade of 6 per cent, either a very deep cut through the railway reserve is required (producing extensive batters into the Bolivia Hill Nature Reserve) or a tunnel is required. The tunnel option was chosen for the purposes of assessment as deep cuts into the railway reserve and into the Bolivia Hill Nature Reserve were considered unacceptable
- The first 400 metres (from the southern project boundary) is an upgrade the existing highway in minor cut and fill
- The alignment then goes into cut for 300 metres to a tunnel portal west of the railway line
- Tunnel under the rail reserve for 1400 metres (as outlined above, open cut produces extensive batters into the Bolivia Hill Nature Reserve which were considered unacceptable)
- Fill then grades down for 700 metres to the existing highway
- The last 400 metres is an upgrade of the existing highway
- Estimated cost $374 million.

7.2.7 Option 5b

Option 5b is a variant to Option 5a but uses steeper grades, which increases the length of the tunnel under the Bolivia Hill Nature Reserve, but reduces the overall route length to connect into the existing highway prior to Pyes Creek Road, limiting the intersection works required.

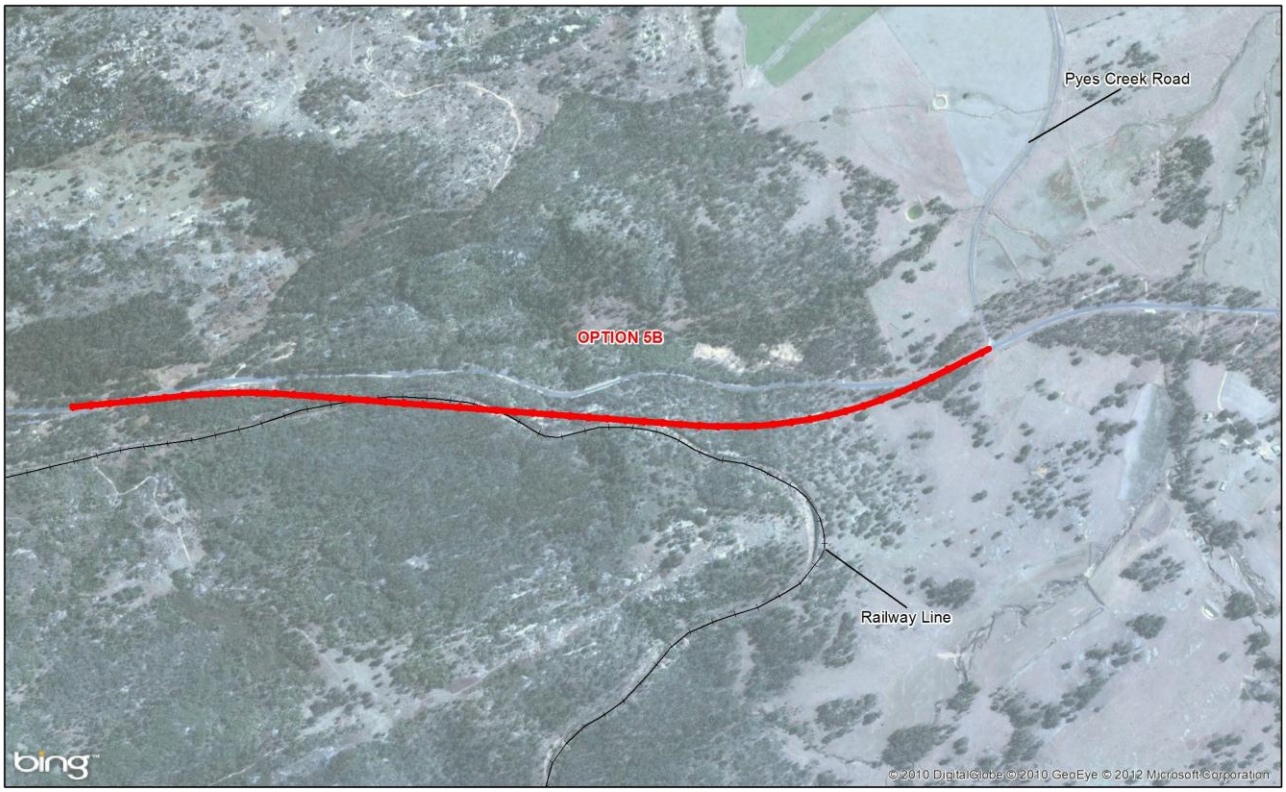


Figure 7-7 **Option 5b**

The key features of this option are:

- Option 5b is 2500 metres long
- This is a variation on Option 5a, shortening the total length
- To achieve the maximum conforming vertical grade of 6 per cent, either a very deep cut through the railway reserve is required (producing extensive batters into the Bolivia Hill Nature Reserve) or a tunnel is required. The tunnel option was chosen for the purposes of assessment as deep cuts into the railway reserve and into the Bolivia Hill Nature Reserve were considered unacceptable
- The first 400 metres (from the southern project boundary) is an upgrade the existing highway in minor cut and fill
- The alignment then goes into cut for 300 metres to a tunnel portal west of the railway line
- Tunnel under the rail reserve for 1300 metres (as outlined above, open cut produces extensive batters into the Bolivia Hill Nature Reserve which were considered unacceptable)
- The alignment is then in cut up to 20 metres deep for 350 metres until it joins the existing highway alignment
- The last 150 metres is an upgrade of the existing highway to the Pyes Creek Road intersection
- Estimated cost $693 million.

7.2.8 Option 6

Option 6 is a variant of Option 4. It also has conforming horizontal and vertical alignments, but presents a shorter route length and connects prior to Pyes Creek Road due to the alignment being further offline at the southern end.

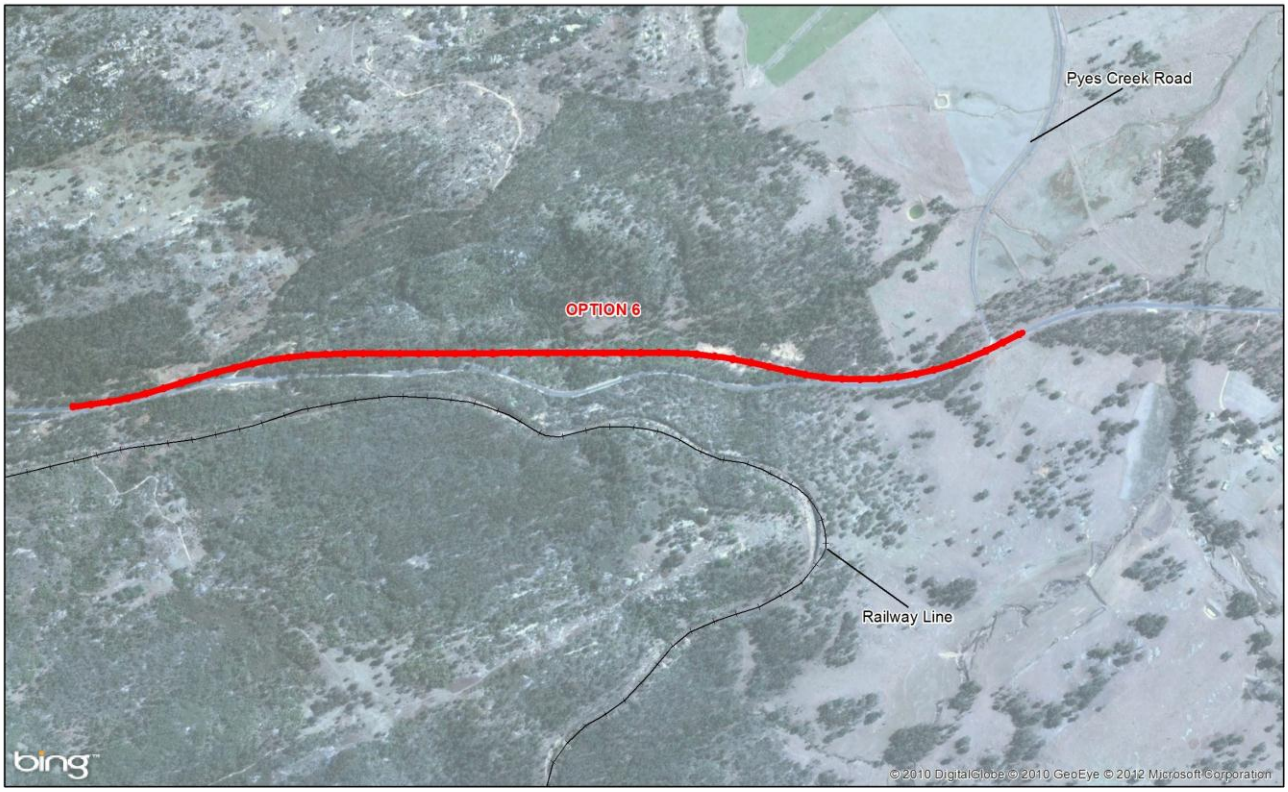


Figure 7-8 **Option 6**

The key features of this option are:

- Option 6 is 2850 metres long
- The option has a maximum conforming vertical grade of 6 per cent
- The first 300 metres (from the southern project boundary) consists of minor cut and fill
- The next 600 metres goes into cut up to 25 metres deep
- The alignment then follows the line of the gully to the west of the highway on the eastern side of the waterway. A major bridge/viaduct up to 1000 metres long is required to keep the roadway out of the creek line
- From the end of the viaduct, fill up to 15 metres high tapers back to the existing highway over approximately 250 metres. The last 400 metres to just past Pyes Creek Road intersection is an upgrade of the existing highway
- Estimated cost $278 million.

7.2.9 Option 7

Option 7 is considered an upgrade to the existing highway, utilising as much of the existing pavement as possible. While it achieves a conforming horizontal alignment it has a non-conforming vertical alignment.

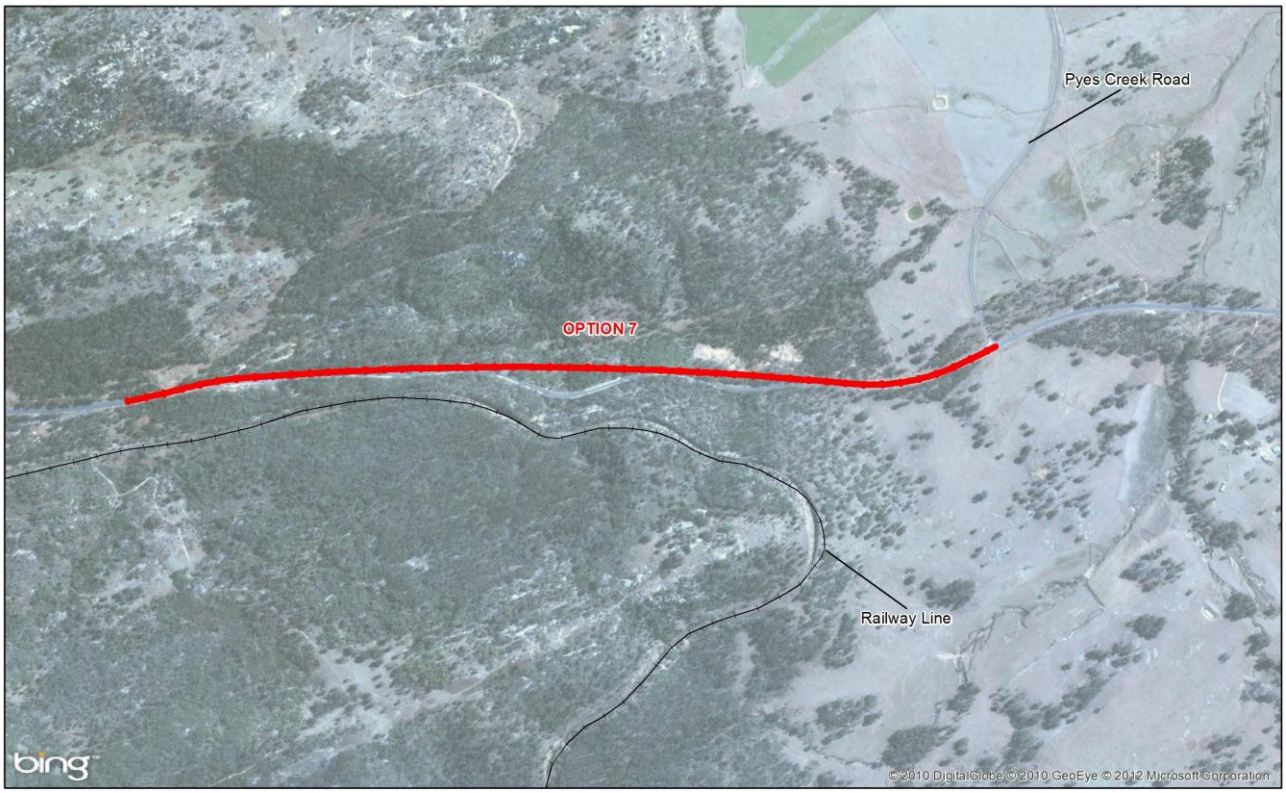


Figure 7-9 **Option 7**

The key features of this option are:

- Option 7 is 1950 metres long
- This option was developed to demonstrate a minimalist treatment of straightening out the bends in the steepest part of the highway. It has non-conforming grades up to 9.0 per cent in order to shorten the length and starts approximately 900 metres north of the other options (from the southern project boundary)
- The first 200 metres will require extensive retaining walls to keep the fill out of the creek line
- A major bridge up to 550 metres long will then be required to keep the road out of the creek line
- From the northern abutment at about eight metres high, fill tapers back 400 metres to the existing highway
- Estimated cost $129 million.

7.2.10 Option 8

Option 8 is a shorter variant of Options 1 and 2; it connects into the existing highway alignment prior to Pyes Creek Road.

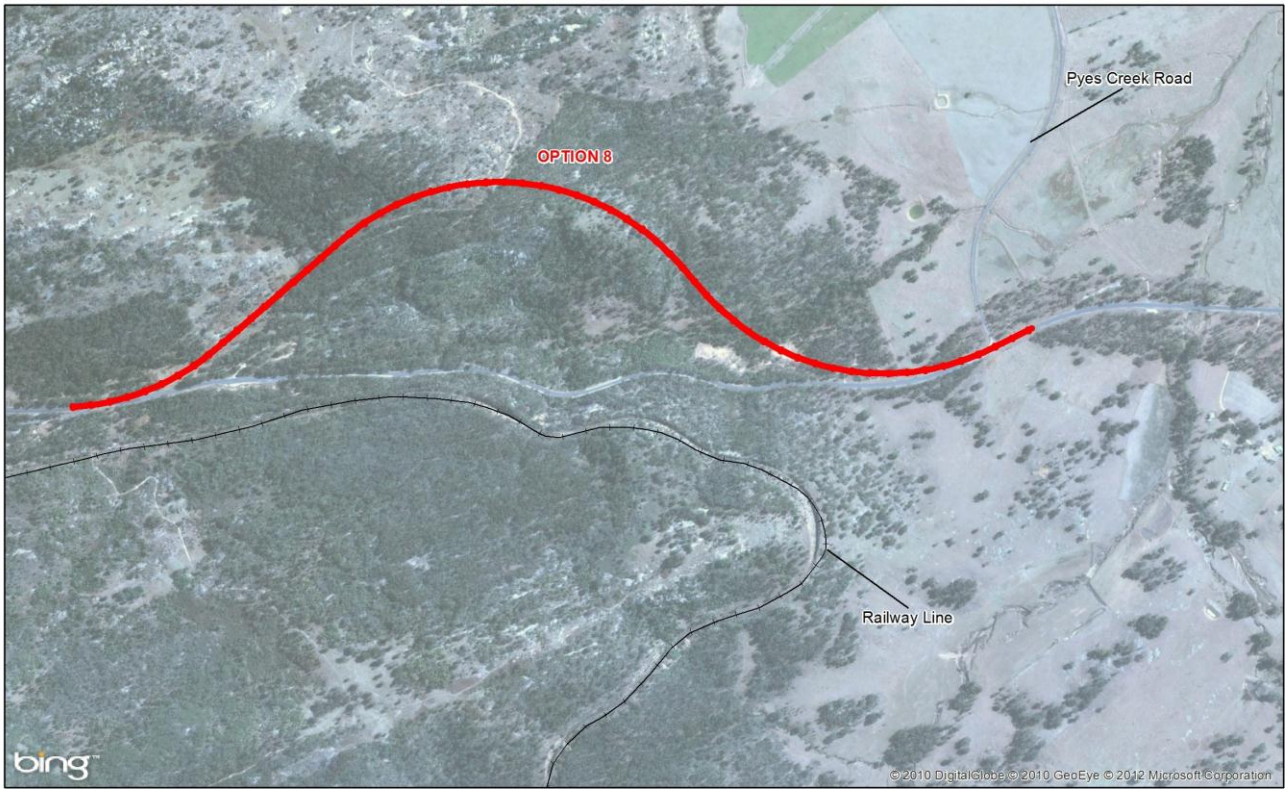


Figure 7-10 **Option 8**

The key features of this option are:

- Option 8 is 3000 metres long
- This option was developed to demonstrate an alignment through areas not covered by other alignments to the west of the existing highway
- Deep cuts and high fills are required to achieve a maximum conforming vertical grade of 6 per cent
- The first 650 metres (from the southern project boundary) consists of minor cut and fill with a bridge over the watercourse in the gully 50 metres long
- The alignment moves into a major cut through the ridge at the western extent of the study area. The cut is 1300 metres long and up to 82 metres deep (or a tunnel approximately 1000 metres long)
- The alignment then moves into extensive fill up to 30 metres high for 500 metres as it grades down to the Brickyard Creek floodplain. Extensive retaining walls and or bridges may be required. A bridge up to 300 metres long will be required across the watercourse to the west of the existing highway
- The last 450 metres to just past Pyes Creek Road intersection is an upgrade of the existing highway
- Estimated cost $1,073 million.

7.2.11 Option 9

Option 9 is a variant of Option 5 with a significantly longer tunnel under the Bolivia Hill Nature Reserve; this eliminates the requirement for bridge structures at the northern tunnel portal.

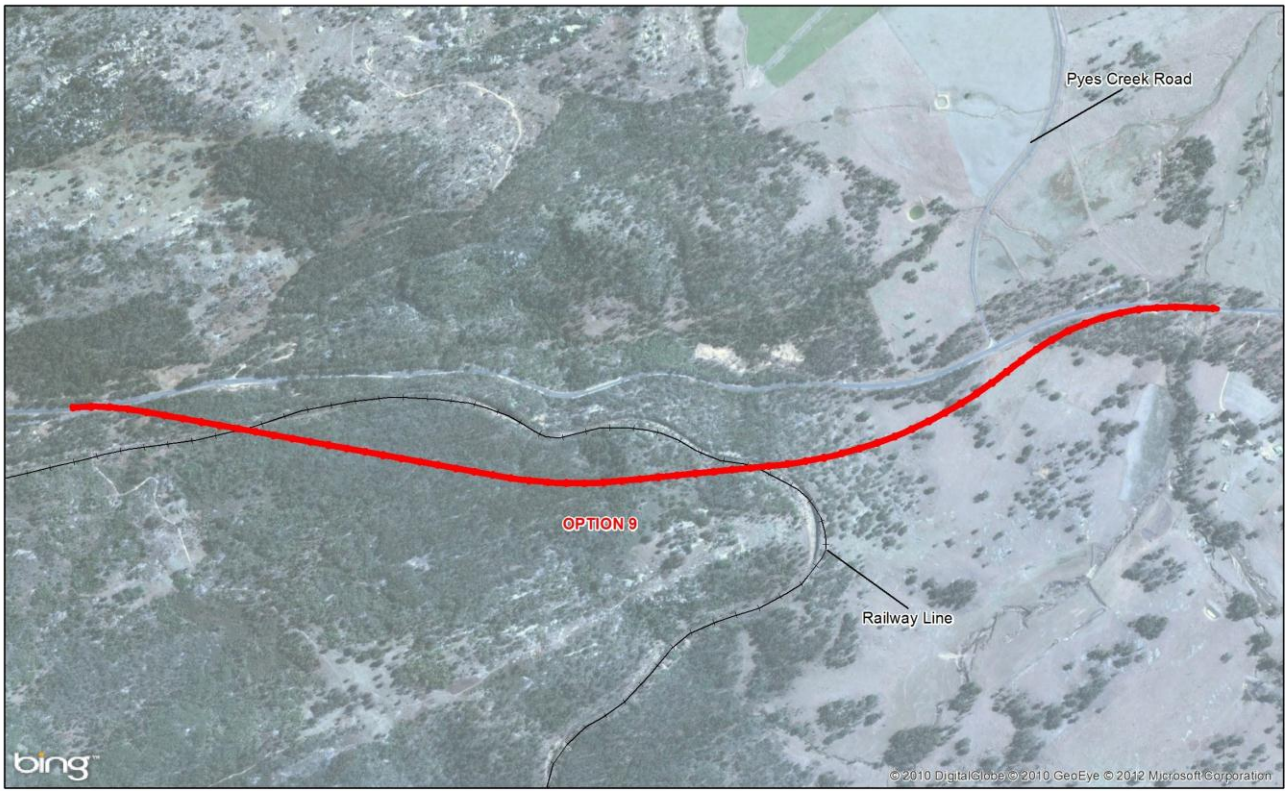


Figure 7-11 **Option 9**

The key features of this option are:

- Option 9 is 3200 metres long
- As with Options 5a and 5b, to achieve the maximum conforming vertical grade of 6 per cent, either a very deep cut is required; producing extensive batters into the Bolivia Hill Nature Reserve or a tunnel is required. The tunnel option was chosen for the purposes of assessment as deep cuts into the railway reserve and into the Bolivia Hill Nature Reserve were considered unacceptable
- The first 250 metres (from the southern project boundary) consists of minor cut and fill
- It is assumed at this stage that the existing railway line must remain; therefore, the alignment goes into cut and then tunnel under the line. Two by two lane tunnels 1700 metres long will be required under the Bolivia Hill Nature Reserve
- From the northern portal of the tunnel, the alignment goes into extensive fill up to 22 metres high for 800 metres, possibly requiring extensive retaining walls
- The last 300 metres is an upgrade of the existing highway
- Estimated cost $890 million.

7.2.12 Option 10

Option 10 is a variant of Option 3 where it attempts to follow the ridgeline to the west of the existing highway while trying to avoid impact to the creek, and considerably reducing the overall length of bridge required.

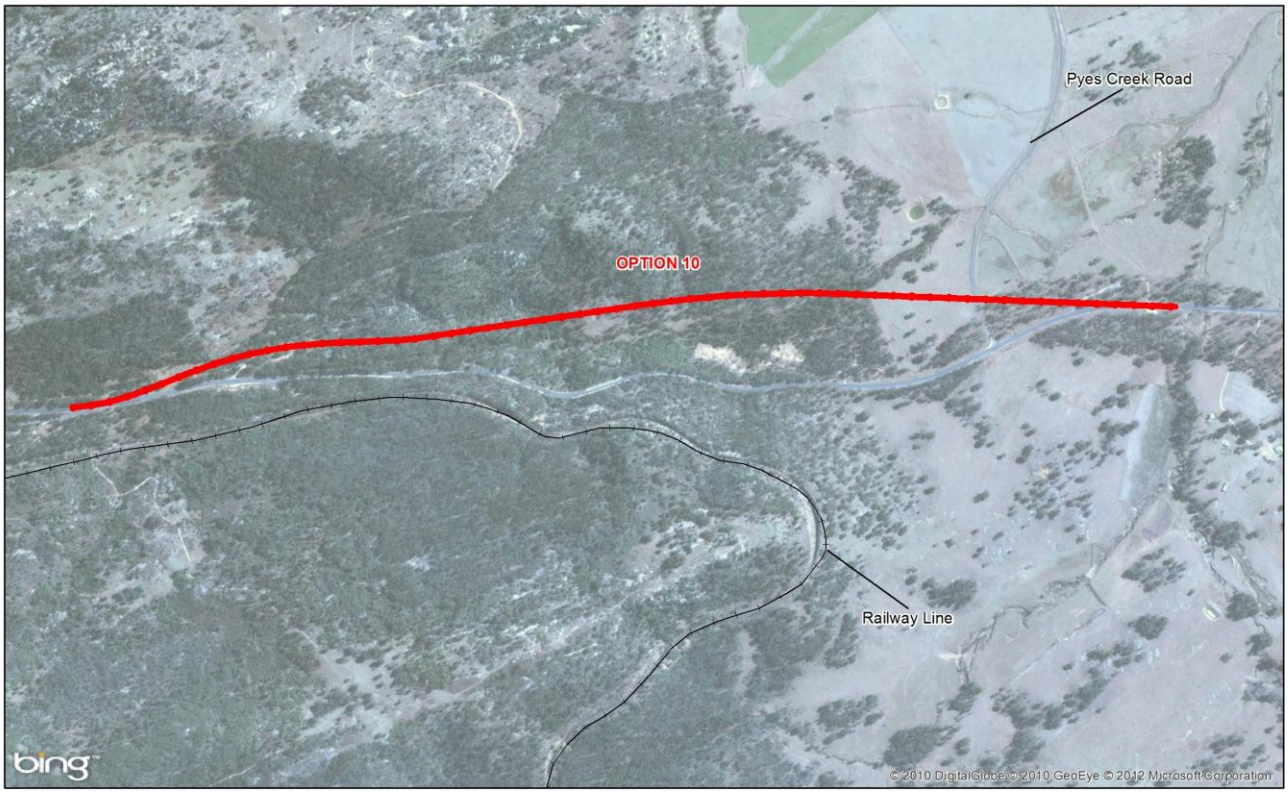


Figure 7-12 **Option 10**

The key features of this option are:

- Option 10 is 2950 metres long. The option is a variation on Option 3 attempting to reduce the length of the viaduct
- The option has a maximum conforming vertical grade of 6 per cent
- The first 300 metres (from the southern project boundary) is in minor cut and fill
- The alignment then moves into extensive cut 650 metres long and up to 25 metres deep
- A major bridge/viaduct up to 900 metres long is then required to keep the road out of the creek line
- The alignment then moves into extensive fill up to 15 metres high for 1000 metres possibly requiring extensive retaining walls. A bridge up to 150 metres long will be required across the watercourse to the west of the existing highway
- The last 300 metres is an upgrade of the existing highway
- Estimated cost $362 million.

7.2.13 Community options

Options suggested by the community (refer to **Section 3.5**) were also assessed. Details of the community options can be found in **Appendix B.**

Community options included the following alignments:

- Several community members suggested an alignment to the western side of the study area. This alignment is similar to Option 1
- Several community members suggested an alignment to the east of the existing highway through Bolivia Hill Nature Reserve. This alignment is similar to Option 9

- Several community members suggested an alignment to the east of the existing highway along the existing railway alignment. This alignment is similar to Options 5a and 5b
- Several community members suggested adopting the current alignment for uphill (southbound) lanes and a new alignment to the west of the existing alignment for a downhill (northbound) lane. While this was considered for Options 6 and 10, it was not put forward as a specific option as it was determined to be economically unviable. The cost of building the single lane off line would not be significantly less than the cost of building the full three lane width off line but the existing alignment would require extensive rehabilitation works as it is currently non-compliant with the project's design criteria
- One community option included some expectation that the upgrade of the existing alignment (widening) could be considered. This proposal is similar to Option 7.

7.3 Phase 2: Initial assessments

The potentially feasible routes from Phase 1 were then assessed by the individual specialists independent from other influences in advance of the route options development workshop process (see below).

Each specialist was required to undertake preparatory assessments of the route options. This then ensured the optimum efficiency of the workshop so that impacts had already been determined prior to the workshop. This assessment was carried out subsequent to the constraints being identified as discussed in **Chapters 5** and **6** above.

The preparatory assessments included:

- Assessment against the project objectives (this involved a detailed assessment of the routes against the objectives and the constraints)
- Identification of preliminary "negotiable" and "non-negotiable" issues. Non-negotiable is the term applied to critical factors which categorically discount a route from further assessment
- Identification of preliminary discards of route options
- Identification of preliminary route preferences.

The specialist investigations categories comprised:

- Community input
- Alignment, staging and access
- Water quality
- Terrestrial ecology
- Flooding and drainage
- Aboriginal and non-Aboriginal heritage
- Climate
- Utilities
- Planning and zoning
- Land use
- Ground conditions
- Cost
- Traffic.

7.4 Phase 3: Internal technical workshop

The assessing and shortlisting of feasible route options was carried out through a workshop process over one day. The key project team members included specialists representing each of the categories described in **Section 7.3**.

At the workshop, the specialists summarised their preparatory work that included:

- An explanation of the category
- An explanation of features of a route which would be either beneficial or undesirable relative to that category
- A preliminary assessment of what are the critical issues, ie those which fundamentally influence the choice of route
- An explanation of study area relative to that category
- General findings of the list of routes
- Specific findings, analysis, assessment and initial preferences
- Identification of non-negotiable issues that would discard the route from further analysis.

The workshop provided an opportunity for participants to appreciate issues arising from other specialist categories resulting in a balanced assessment between specialist areas and issues.

The route options were assessed in turn to determine how they met the project objectives. This included identification of routes that failed to meet critical objectives and were therefore discarded.

A simple comparison exercise was then performed for every route comparing on a numerical scale how well the route met the project objectives.

The scale was as follows:

4 fully meets the criteria

3 significantly meets the criteria

2 partially meets the criteria

1 mostly does not meet the criteria

0 non-negotiable => discard

For each objective, combinations of specialist categories were applicable, ie a route may have attracted a different outcome for each specialist category for a specific objective. The workshop process included debate on each of these scenarios and determined a collective result.

7.4.1 Phase 3: Internal technical workshop outcomes

The internal technical workshop produced a provisional shortlist of route options and identified issues that require further detailed analysis in the next stage of the project.

The workshop's assessment of each option is provided in **Table 7-2**. The table includes a summary of the initial assessment of the list of options against project objectives and assessment criteria. The rationale behind the scoring is included in **Appendix J**.

7.4.1.1 Ranking of options

The options were initially ranked 1 (best) to 11 (worst) against the total score for each option.

To test the validity of this ranking, the following methods were also used:

- Equally weight each objective
  - Calculate the average score for Road Safety, Efficiency, Environment and Value for Money
  - Add each average score to obtain a score out of 16

- Rank each objective on total score for the objective and then sum the rankings. The option with the lowest score ranks best.

The rankings showed consistency over the three methods. The key issues and the outcomes of the workshop process were collated and are included in **Appendix J.**

Table 7-3 (following **Table 7-2**) provides an overall summary of the outcomes of the initial assessment of the list of options against the project objectives and assessment criteria.

Table 7-2 Rationale behind workshop scoring for each option

Option 1

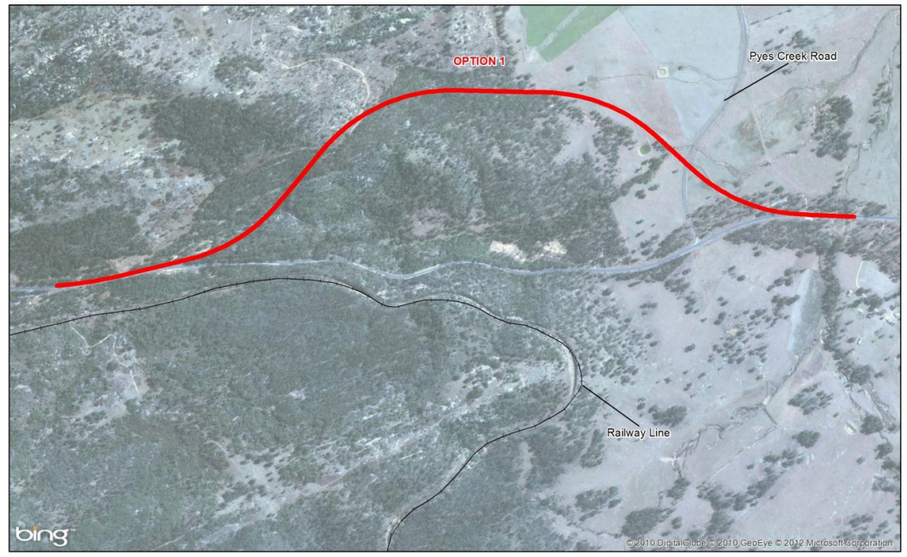
Option 1 attempts, in part, to follow the former Cobb & Co road to the west of the existing alignment to reduce property acquisition by using an existing road reserve where possible.

Workshop outcomes

Option 1 scored poorly for constructability due to the long and deep cutting in very hard rock. The variable nature of the hard rock presents high risk and construction difficulties which are reflected in the high cost. Option 1 also scored poorly against the environmental objectives. The deep cut and high fills leave a very large footprint and would have a considerable impact on flora and fauna and create a significant visual impact. The cut would also require a large amount of rock to be transported away from site.

Overall, Option 1 scored very poorly against all the objectives and was not shortlisted to be taken forward for further investigation and design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	• Reduced crash rate and injuries • Improved road safety standards – improved geometry standard • Minimise conflict points on the highway (intersections) • Constructability • Work Health and safety in construction and maintenance.	6 (equal)	• Road safety will be improved with the vertical and horizontal alignment to improved geometry standards • Scores poorly for constructability and work health and safety in construction and maintenance due to the long and deep cutting in very hard rock
Improve road transport productivity efficiency and reliability of travel	• Reduced road freight user costs • Reduced travel time • Target a route level of service of A • Increase road network capacity.	5 (equal)	• Although the alignment has conforming horizontal and vertical geometry, scores lower in comparison with other options due to the use of minimum radius curves.
Minimise the impact on the natural, cultural and built environment	• Impact on fauna habitat including threatened species • Impact on flora including threatened species • Water quality • Air quality • Noise and vibration impact • Aboriginal and non-Aboriginal heritage • Stormwater and drainage • Residential and commercial properties impacted • Ecological sustainability • Visual impact and amenity.	9 (equal)	• Scores poorly on impact to flora and fauna habitat due to the long, deep cut that leaves a very large footprint • Scores well for non-Aboriginal impacts as it avoids most of the sensitive areas, only a small portion in Bolivia Station would be affected by the route • Scores poorly for Aboriginal heritage as the route passes through areas of high and moderate Aboriginal heritage sensitivity • Scores poorly in relation to surface water quality due to interference with existing floodplain and creek realignment • Significant interference due to two proposed creek crossings results in a poor score for flooding and drainage • Scores poorly on potential to use recycled or waste material due to the large amount of rock excavated from the large cutting that would need to be transported away from site • Scores poorly on visual impact with a large footprint due to the large cuts and fills.
Provide value for money	• Cost benefit ratios • NPV over 30 years • Road user costs and benefits • Infrastructure operating costs (including maintenance). • Comparative project costs.	8 (equal)	• Cost $584 M • $455 M more than lowest cost option mainly due to the very large quantity of cut through hard rock • Cost is considered excessive.

Option 2

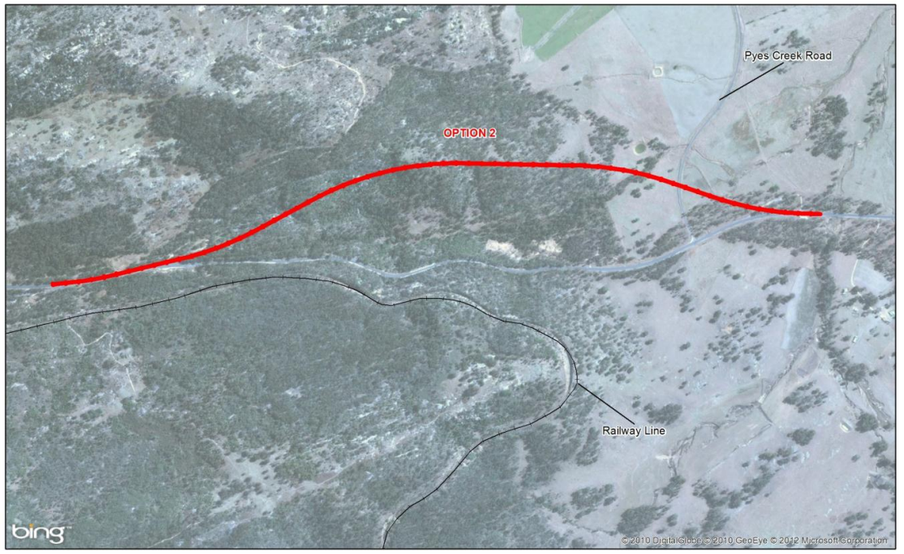
Option 2 is similar to Option 1 but with an attempt to reduce the amount of hard rock excavation required and the overall route length.

Workshop outcomes

Option 2 scored poorly for constructability due to the long and deep cutting in very hard rock. The variable nature of the hard rock presents high risk and construction difficulties which are reflected in the high cost. Option 2 also scored poorly against the environmental objectives. The deep cut and high fills leave a large footprint and would have a considerable impact on flora and fauna and create a significant visual impact, although the impacts are not as significant as in Option 1.

Overall Option 2 did not score well against the objectives. However, as the workshop participants agreed that Options 3 and 4 were variations of Options 10 and 6 respectively (these variations can be explored during refinement of the shortlisted options during the preliminary concept design stage of the project), the overall ranking of Option 2 was enough for the option to be investigated in the next stage of design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	• Reduced crash rate and injuries • Improved road safety standards – improved geometry standard • Minimise conflict points on the highway (intersections) • Constructability • Work Health and safety in construction and maintenance.	5	• Road safety will be improved with the vertical and horizontal alignment to improved geometry standards • Scores poorly for constructability and work health and safety in construction and maintenance due to the long and deep cutting in very hard rock.
Improve road transport productivity efficiency and reliability of travel	• Reduced road freight user costs • Reduced travel time • Target a route level of service of A • Increase road network capacity.	5 (equal)	• Although the alignment has conforming horizontal and vertical geometry, scores poorly in comparison with other options due to the use of minimum radius curves.
Minimise the impact on the natural, cultural and built environment	• Impact on fauna habitat including threatened species • Impact on flora including threatened species • Water quality • Air quality • Noise and vibration impact • Aboriginal and non-Aboriginal heritage • Stormwater and drainage • Residential and commercial properties impacted • Ecological sustainability • Visual impact and amenity.	6	• Scores well on the impact to flora and fauna as it avoids the Bolivia Hill Nature Reserve and has a smaller area of cut in comparison to other options, but the route would still require removal of some vegetation • Scores well for non-Aboriginal impacts as it avoids most of the sensitive areas, only a small portion in Bolivia Station would be affected by the route • Scores poorly for Aboriginal heritage as the route passes through areas of high and moderate Aboriginal heritage sensitivity • Scores poorly in relation to surface water quality due to interference with existing floodplain and creek realignment • Significant interference due to two proposed creek crossings results in a poor score for flooding and drainage • Scores poorly on potential to use recycled or waste material due to the large amount of rock excavated from the large cutting that would need to be transported away from site • Scores poorly on visual impact with a large footprint due to the large cuts and fills.
Provide value for money	• Cost benefit ratios • NPV over 30 years • Road user costs and benefits • Infrastructure operating costs (including maintenance). • Comparative project costs.	3 (equal)	• Cost $316 M • $187 M more than lowest cost option, mainly due to the large quantity of cut through hard rock • Ranked equal third on cost.

Option 3

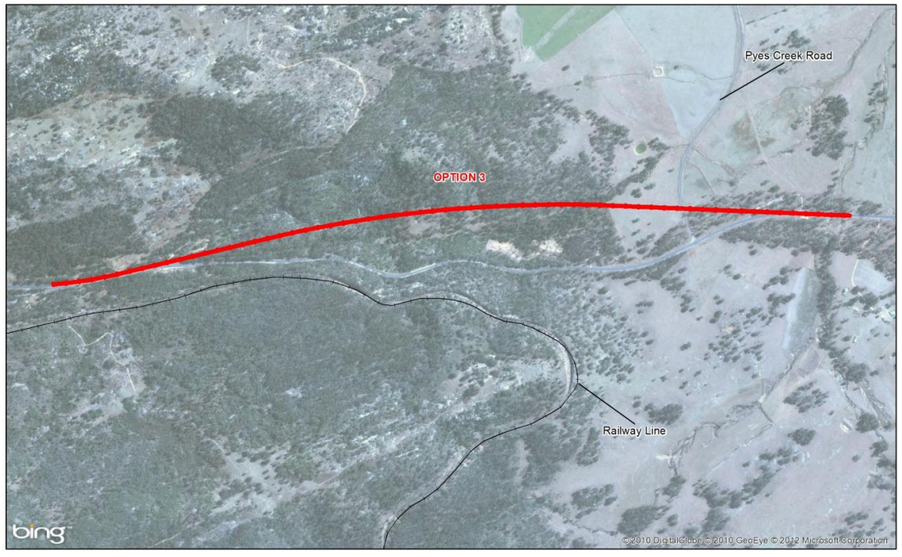
Option 3 achieves the best geometric outcomes as it is the most direct with minimal horizontal direction change; this requires, however, a major bridge/viaduct.

Workshop outcomes

Option 3 scored well for constructability due to minimal cutting in very hard rock. Option 3 scored reasonably well against the environmental objectives due to its smaller footprint having a smaller impact on flora and fauna. The cost of the option was large due to the requirement for a very long bridge/viaduct required to minimise the impact on the creek to the west of the existing highway.

Overall Option 3 scored well against the majority of the objectives, however, workshop participants considered the alignment to be similar to Option 10. Option 3 was therefore considered as a variation to Option 10 (which had a better overall ranking than Option 3).

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	• Reduced crash rate and injuries • Improved road safety standards – improved geometry standard • Minimise conflict points on the highway (intersections) • Constructability • Work Health and safety in construction and maintenance.	1 (equal)	• Road safety will be improved with the vertical and horizontal alignment to improved geometry standards • Acceptable score for constructability and work health and safety in construction and maintenance due to no major cut in hard rock.
Improve road transport productivity efficiency and reliability of travel	• Reduced road freight user costs • Reduced travel time • Target a route level of service of A • Increase road network capacity.	1 (equal)	• The alignment has conforming horizontal and vertical geometry. Scores higher than other conforming alignments with minimum radius curves.
Minimise the impact on the natural, cultural and built environment	• Impact on fauna habitat including threatened species • Impact on flora including threatened species • Water quality • Air quality • Noise and vibration impact • Aboriginal and non-Aboriginal heritage • Stormwater and drainage • Residential and commercial properties impacted • Ecological sustainability • Visual impact and amenity.	3	• Scores well on the impact to flora and fauna as it avoids the Bolivia Hill Nature Reserve and has a smaller area of cut in comparison to other options, but the route will still require removal of some vegetation • Scores well for non-Aboriginal impacts as it avoids most of the sensitive areas, only a small portion in Bolivia Station would be affected by the route • Scores poorly for Aboriginal heritage as the route passes through a large area of high Aboriginal sensitivity along the 100yr ARI floodline • A large viaduct/bridge is proposed which may minimise the creek realignment required • The proposed viaduct results in a poor score for flooding and drainage due to the potential for piers and foundations which may impact on existing hydrology • Scores well for recycling of waste material as the rock cut can be used in fill on site.
Provide value for money	• Cost benefit ratios • NPV over 30 years • Road user costs and benefits • Infrastructure operating costs (including maintenance). • Comparative project costs.	6 (equal)	• Cost $445 M • $216 M more than lowest cost option mainly due to the very long bridge/viaduct • Ranked equal sixth on cost.

Option 4

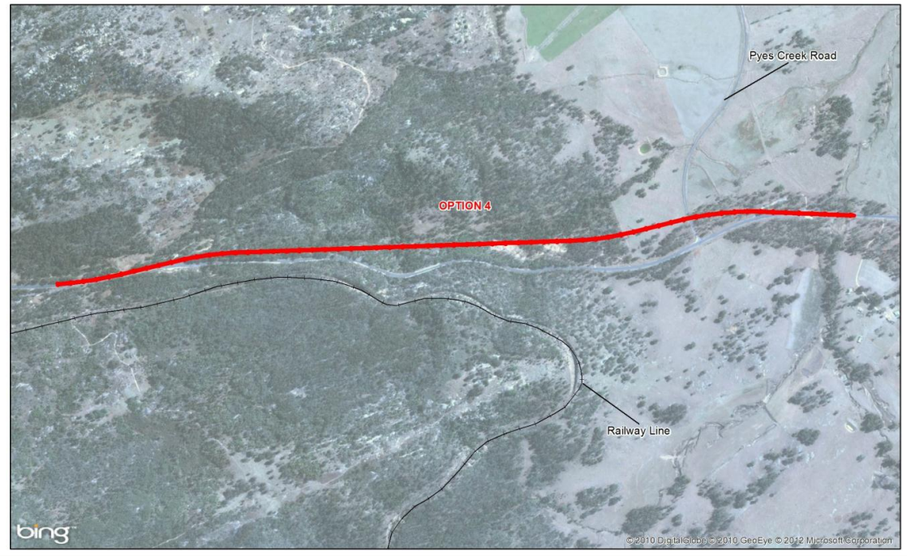
Option 4 aims to keep the alignment as close the existing highway alignment as possible while achieving conforming horizontal and vertical alignments.

Workshop outcomes

Option 4 scored well for constructability due to minimal cutting in very hard rock. Option 4 scored reasonably well against the environmental objectives due to its smaller footprint having a smaller impact on flora and fauna. The cost of the option was large due to the requirement for a very long bridge/viaduct required to minimise the impact on the creek to the west of the existing highway.

Overall Option 4 scored well against the majority of the objectives, however, workshop participants considered the alignment to be similar to Option 6. Option 4 was therefore considered as a variation to Option 6 (which had a better overall ranking than Option 4).

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	• Reduced crash rate and injuries • Improved road safety standards – improved geometry standard • Minimise conflict points on the highway (intersections) • Constructability • Work Health and safety in construction and maintenance.	1 (equal)	• Road safety would be improved with the vertical and horizontal alignment to improved geometry standards • Acceptable score for constructability and work health and safety in construction and maintenance due to no major cut in hard rock.
Improve road transport productivity efficiency and reliability of travel	• Reduced road freight user costs • Reduced travel time • Target a route level of service of A • Increase road network capacity.	1 (equal)	• The alignment has conforming horizontal and vertical geometry. Scores higher than other conforming alignments with minimum radius curves.
Minimise the impact on the natural, cultural and built environment	• Impact on fauna habitat including threatened species • Impact on flora including threatened species • Water quality • Air quality • Noise and vibration impact • Aboriginal and non-Aboriginal heritage • Stormwater and drainage • Residential and commercial properties impacted • Ecological sustainability • Visual impact and amenity.	4	• Scores well on the impact to flora and fauna as it avoids the Bolivia Hill Nature Reserve and has a smaller area of cut in comparison to other options, but the route would still require removal of some vegetation • Scores well for non-Aboriginal impacts as it avoids most of the sensitive areas, only a small portion in Bolivia Station would be affected by the route • Scores poorly for Aboriginal heritage as the route passes through a large area of high Aboriginal sensitivity along the 100yr ARI floodline • A large viaduct/bridge is proposed which may minimise the creek realignment required and interference with the floodplain • The proposed viaduct, while shorter than Option 3, would result in a poor score for flooding and drainage due to the potential for piers and foundations to impact on existing hydrology.
Provide value for money	• Cost benefit ratios • NPV over 30 years • Road user costs and benefits • Infrastructure operating costs (including maintenance). • Comparative project costs.	6 (equal)	• Cost $430 M • $301 M more than lowest cost option due to the major bridge/viaduct. • Ranked equal sixth on cost.

Option 5a

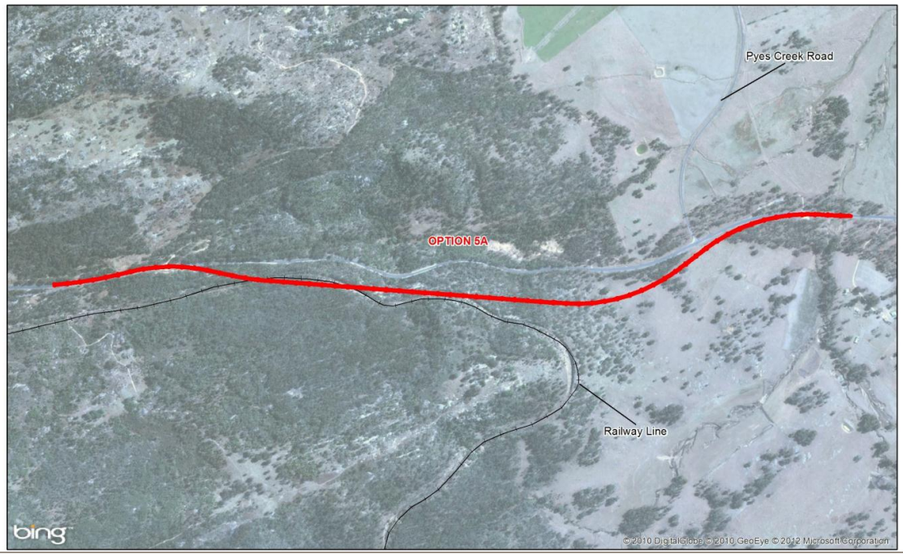
Option 5a is an eastern option that requires a tunnel underneath Bolivia Hill Nature Reserve that would ensure no disturbance to the nature reserve and the Main Northern Railway line.

Workshop outcomes

Option 5a scored poorly for constructability due to tunnelling required in very hard rock. Tunnelling has additional design, safety and maintenance requirements that are technically challenging in this terrain. The variable nature of the hard rock presents high risk and construction difficulties which are reflected in the cost.
Option 5a scores poorly against the environmental objectives due to the large amount of rock excavated from the tunnel that would need to be transported away from site. Tunnelling also requires a large amount of water and therefore tunnelling activities may impact on surface water quality due to the requirement for extensive wastewater ponds.

Overall, Option 5a scored poorly against the majority of the objectives and was not shortlisted to be taken forward for further investigation and design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	• Reduced crash rate and injuries • Improved road safety standards – improved geometry standard • Minimise conflict points on the highway (intersections) • Constructability • Work Health and safety in construction and maintenance.	6 (equal)	• Road safety would be improved with the vertical and horizontal alignment to improved geometry standards • Scores poorly for constructability and work health and safety in construction and maintenance due to tunnelling in hard rock.
Improve road transport productivity efficiency and reliability of travel	• Reduced road freight user costs • Reduced travel time • Target a route level of service of A • Increase road network capacity.	5 (equal)	• Although the alignment has conforming horizontal and vertical geometry, scores poorly in comparison with other options due to the use of minimum radius curves.
Minimise the impact on the natural, cultural and built environment	• Impact on fauna habitat including threatened species • Impact on flora including threatened species • Water quality • Air quality • Noise and vibration impact • Aboriginal and non-Aboriginal heritage • Stormwater and drainage • Residential and commercial properties impacted • Ecological sustainability • Visual impact and amenity.	9 (equal)	• Scores poorly for impacts to flora and fauna as the route passes through the Bolivia Hill Nature Reserve • Scores poorly for impacts to non-Aboriginal heritage as the route passes through a large area of highly sensitive heritage land • Scores well for Aboriginal heritage as it avoids highly sensitive land and only impacts a small portion of moderate sensitivity • Scores well in regard to surface water quality as it avoids the existing hydrology constraints, however construction activities may impact on surface water quality • Scores well as this option avoids the existing watercourse • Scores poorly on potential to use recycled or waste material due to the large amount of rock excavated from the tunnel that would need to be transported away from site.
Provide value for money	• Cost benefit ratios • NPV over 30 years • Road user costs and benefits • Infrastructure operating costs (including maintenance). • Comparative project costs.	3 (equal)	• Cost $374 M • $245 M more than lowest cost option due to the very high cost of tunnelling through hard rock • Ranked equal third on cost.

Option 5b

Option 5b is a variant to Option 5a but uses steeper grades, which increases the length of the tunnel under the Bolivia Hill Nature Reserve, but reduces the overall route length to connect into the existing highway prior to Pyes Creek Road, limiting the intersection works required.

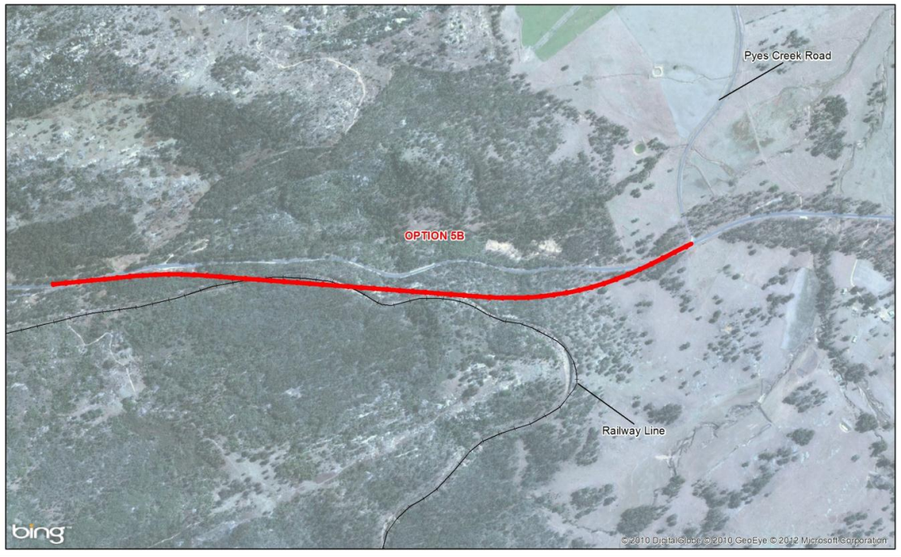
Workshop outcomes

Option 5b scored poorly for constructability due to tunnelling required in very hard rock. Tunnelling has additional design, safety and maintenance requirements that are technically challenging in this terrain. The variable nature of the hard rock presents high risk and construction difficulties which are reflected in the cost.

Option 5b scores poorly against the environmental objectives due to the large amount of rock excavated from the tunnel that would need to be transported away from site. Tunnelling also requires a large amount of water and therefore tunnelling activities may impact on surface water quality due to the requirement for extensive wastewater ponds.

Overall, Option 5b scored poorly against the majority of the objectives and was not shortlisted to be taken forward for further investigation and design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	• Reduced crash rate and injuries • Improved road safety standards – improved geometry standard • Minimise conflict points on the highway (intersections) • Constructability • Work Health and safety in construction and maintenance.	6 (equal)	• Road safety would be improved with the vertical and horizontal alignment to improved geometry standards • Scores poorly for constructability and work health and safety in construction and maintenance due to tunnelling in hard rock.
Improve road transport productivity efficiency and reliability of travel	• Reduced road freight user costs • Reduced travel time • Target a route level of service of A • Increase road network capacity.	1 (equal)	• The alignment has conforming horizontal and vertical geometry. Scores higher than other conforming alignments with minimum radius curves.
Minimise the impact on the natural, cultural and built environment	• Impact on fauna habitat including threatened species • Impact on flora including threatened species • Water quality • Air quality • Noise and vibration impact • Aboriginal and non-Aboriginal heritage • Stormwater and drainage • Residential and commercial properties impacted • Ecological sustainability • Visual impact and amenity.	9 (equal)	• Scores poorly for impacts to flora and fauna as the route passes through the Bolivia Hill Nature Reserve • Scores poorly for impacts to non-Aboriginal heritage as the route passes through a large area of highly sensitive heritage land • Scores well for Aboriginal heritage as it avoids highly sensitive land and only impacts a small portion of moderate sensitivity • Scores well in regard to surface water quality as it avoids the existing hydrology constraints however construction activities may impact on surface water quality • Scores well as this option avoids the existing watercourse • Scores poorly on potential to use recycled or waste material due to the large amount of rock excavated from the tunnel that would need to be transported away from site.
Provide value for money	• Cost benefit ratios • NPV over 30 years • Road user costs and benefits • Infrastructure operating costs (including maintenance) • Comparative project costs.	8 (equal)	• Cost $693 M • $564 M more than lowest cost option due to the very high cost of tunnelling through hard rock • Cost is considered excessive.

Option 6

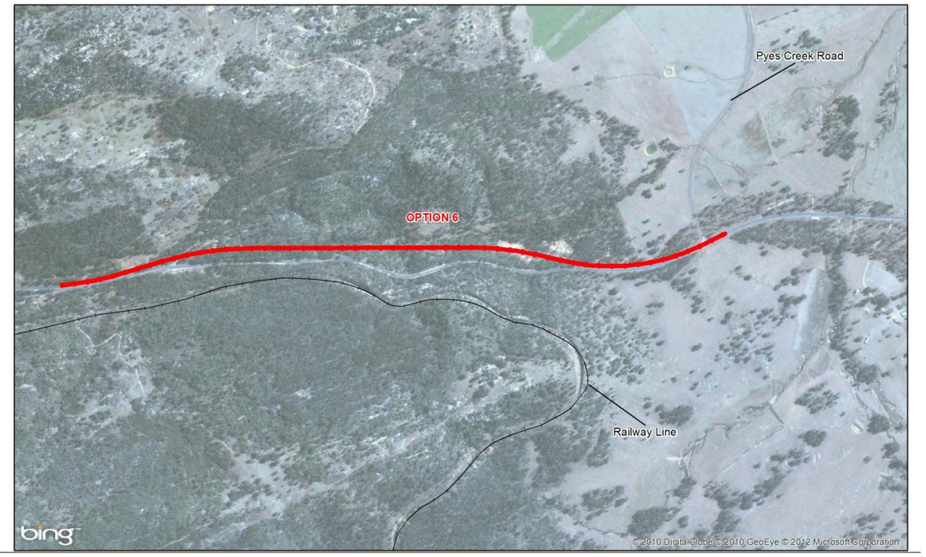
Option 6 is a variant of Option 4. It also has confirming horizontal and vertical alignments, but presents a shorter route length and connects prior to Pyes Creek Road due to the alignment being further offline at the southern end.

Workshop outcomes

Option 6 scored well for constructability due to minimal cutting in very hard rock. Option 6 also scored well against the environmental objectives due to its smaller footprint having a smaller impact on flora and fauna. Although the option requires a long bridge/viaduct to minimise the impact on the creek to the west of the existing highway, it is shorter than some other options and the overall cost of the option is therefore reduced.

Overall, Option 6 scored well against the majority of the objectives and the workshop participants considered that it should be investigated in the next stage of design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	• Reduced crash rate and injuries • Improved road safety standards – improved geometry standard • Minimise conflict points on the highway (intersections) • Constructability • Work Health and safety in construction and maintenance.	1 (equal)	• Road safety will be improved with the vertical and horizontal alignment to improved geometry standards • Acceptable score for constructability and work health and safety in construction and maintenance due to no major cut in hard rock.
Improve road transport productivity efficiency and reliability of travel	• Reduced road freight user costs • Reduced travel time • Target a route level of service of A • Increase road network capacity.	5 (equal)	• Although the alignment has conforming horizontal and vertical geometry, scores poorly in comparison with other options due to the use of minimum radius curves.
Minimise the impact on the natural, cultural and built environment	• Impact on fauna habitat including threatened species • Impact on flora including threatened species • Water quality • Air quality • Noise and vibration impact • Aboriginal and non-Aboriginal heritage • Stormwater and drainage • Residential and commercial properties impacted • Ecological sustainability • Visual impact and amenity.	2	• Scores well on the impact to flora and fauna as it avoids the Bolivia Hill Nature Reserve and has a smaller area of cut in comparison to other options, but the route will still require removal of some vegetation • Scores high for non-Aboriginal heritage as it avoids all areas of sensitivity • Scores poorly for Aboriginal heritage as the route passes through a large area of high Aboriginal sensitivity along the 100yr ARI floodline (but less of an impact than Option 3) • A large viaduct/bridge is proposed which may minimise the creek realignment for the main watercourse and interference with the floodplain • The proposed viaduct, while shorter than Option 3, would result in a poor score for flooding and drainage due to the potential for numerous piers and foundations to impact on existing hydrology and minor watercourse realignment • Scores well for recycling of waste material as the rock cut can be used in fill on site.
Provide value for money	• Cost benefit ratios • NPV over 30 years • Road user costs and benefits • Infrastructure operating costs (including maintenance). • Comparative project costs.	2	• Cost $278 M • $149 M more than lowest cost option, mainly due to the major bridge/viaduct.

Option 7

Option 7 is considered an upgrade to the existing highway, utilising as much of the existing pavement as possible. While it achieves a conforming horizontal alignment it has a non-conforming vertical alignment.

Workshop outcomes

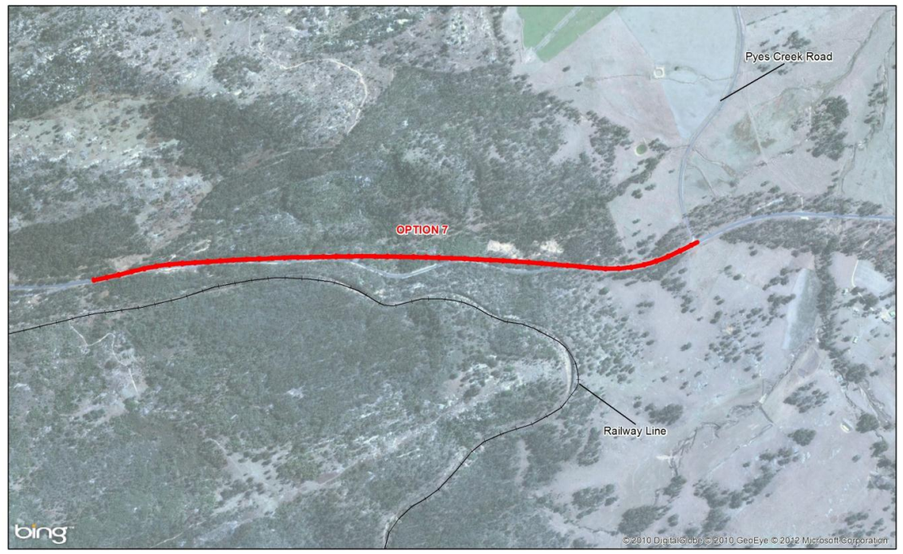
Option 7 scores poorly against other options on constructability and work health and safety in construction and maintenance as the majority of the length will be constructed under traffic control next to existing highway traffic. It also ranks last against the objective of improving road transport productivity efficiency and reliability of travel due to the 9% grade compared to 6% maximum of the other options. Option 7 does, however, score will against the environmental objectives, with a small area of disturbance of flora and fauna. Option 7 ranks as the lowest cost option, being $149 M less than the next lowest cost option.

Although Option 7 did not fully comply with the design criteria (in that it the vertical alignment exceeded 6% slope), participants agreed that it should not be eliminated from the assessment as:

- Minor upgrade of the existing alignment should be an option for consideration
- Upgrading of the existing alignment was suggested by many community stakeholders.

Overall, Option 7 scored well and the workshop participants considered that it should be investigated in the next stage of design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	• Reduced crash rate and injuries • Improved road safety standards – improved geometry standard • Minimise conflict points on the highway (intersections) • Constructability • Work Health and safety in construction and maintenance.	11	• Although not unsafe, ranks last against improved geometry standard due to the vertical geometry containing a 9% grade where all other options have a conforming 6% maximum grade • Scores poorly against other options on constructability and work health and safety in construction and maintenance as the majority of the length will be constructed under traffic control next to highway traffic
Improve road transport productivity efficiency and reliability of travel	• Reduced road freight user costs • Reduced travel time • Target a route level of service of A • Increase road network capacity.	11	• Ranks last due to the 9% grade compared to 6% maximum of the other options.
Minimise the impact on the natural, cultural and built environment	• Impact on fauna habitat including threatened species • Impact on flora including threatened species • Water quality • Air quality • Noise and vibration impact • Aboriginal and non-Aboriginal heritage • Stormwater and drainage • Residential and commercial properties impacted • Ecological sustainability • Visual impact and amenity.	1	• Scores well on the impact to flora and fauna as it avoids the Bolivia Hill Nature Reserve and has a smaller area of cut in comparison to other options, but the route will still require removal of some vegetation • Scores well for non-Aboriginal heritage as it avoids most areas of sensitivity (small impact in a small area along the rail line) • Scores poorly for Aboriginal heritage as the route passes through a large area of high Aboriginal sensitivity along the 100yr ARI floodline (but less of an impact than Option 3) • Scores poorly in relation to surface water quality due to interference with minor tributaries and resulting realignment required • Significant interference due to two proposed culvert crossings and large viaduct/bridge required results in a poor score for flooding and drainage • Scores well for recycling of waste material as the rock cut can be used in fill on site.
Provide value for money	• Cost benefit ratios • NPV over 30 years • Road user costs and benefits • Infrastructure operating costs (including maintenance). • Comparative project costs.	1	• Cost $129 M • Lowest cost option.

Option 8

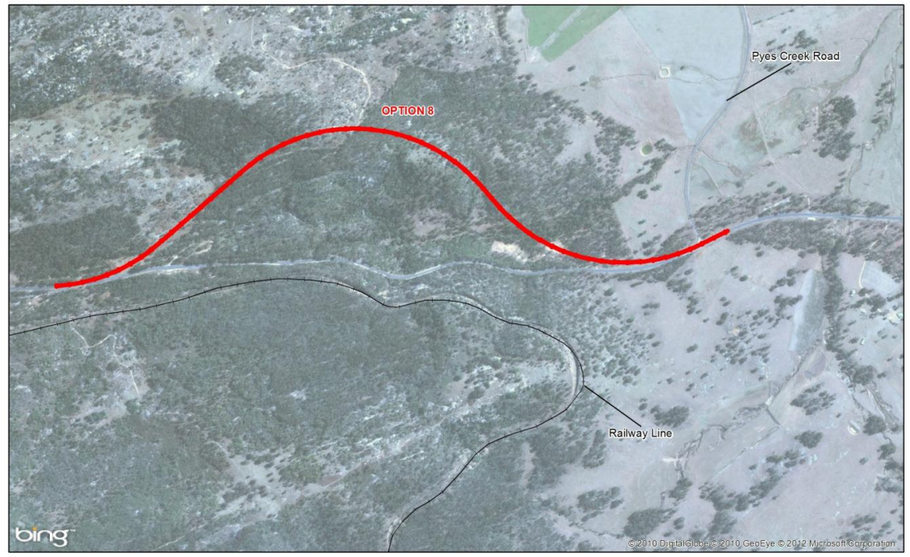
Option 8 is a shorter variant of Options 1 and 2, it connects into the existing highway alignment prior to Pyes Creek Road.

Workshop outcomes

Option 8 scored poorly for constructability due to the long and deep cutting in very hard rock. The variable nature of the hard rock presents high risk and construction difficulties which are reflected in the high cost. Option 8 also scored poorly against the environmental objectives. The deep cut and high fills leave a very large footprint and have a considerable impact on flora and fauna and create a significant visual impact. The cut would also require a large amount of rock to be transported away from site.

Overall, Option 8 scored very poorly against all the objectives and was not shortlisted to be taken forward for further investigation and design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	• Reduced crash rate and injuries • Improved road safety standards – improved geometry standard • Minimise conflict points on the highway (intersections) • Constructability • Work Health and safety in construction and maintenance.	6 (equal)	• Road safety will be improved with the vertical and horizontal alignment to improved geometry standards • Scores poorly for constructability and work health and safety in construction and maintenance due to the long and deep cutting in very hard rock.
Improve road transport productivity efficiency and reliability of travel	• Reduced road freight user costs • Reduced travel time • Target a route level of service of A • Increase road network capacity.	5 (equal)	• Although the alignment has conforming horizontal and vertical geometry, scores poorly in comparison with other options due to the use of minimum radius curves.
Minimise the impact on the natural, cultural and built environment	• Impact on fauna habitat including threatened species • Impact on flora including threatened species • Water quality • Air quality • Noise and vibration impact • Aboriginal and non-Aboriginal heritage • Stormwater and drainage • Residential and commercial properties impacted • Ecological sustainability • Visual impact and amenity.	7 (equal)	• Scores poorly on impact on flora and fauna habitat due to the long, deep cut that leaves a very large footprint • Scores well for non-Aboriginal heritage as it avoids all areas of sensitivity • Scores poorly for Aboriginal heritage as the route passes through large areas of high and moderate Aboriginal heritage sensitivity • Scores poorly in relation to surface water quality due to significant interference with existing watercourse alignment • Significant interference on flooding and drainage due to realignment and large bridge required over floodplain • Scores poorly on potential to use recycled or waste material due to the large amount of rock excavated from the large cutting that would need to be transported away from site • Scores poorly on visual impact with a large footprint due to the large cuts and fills.
Provide value for money	• Cost benefit ratios • NPV over 30 years • Road user costs and benefits • Infrastructure operating costs (including maintenance) • Comparative project costs.	8 (equal)	• Cost $1,073 M • $944 M more than lowest cost option due to the excessive amount of cut through hard rock • Cost is considered excessive.

Option 9

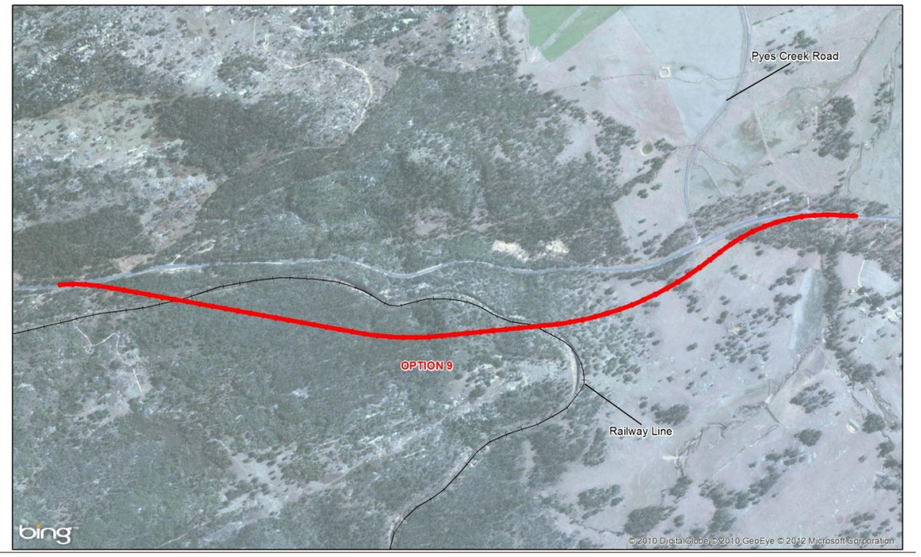
Option 9 is a variant of Option 5 with a significantly longer tunnel under the Bolivia Hill Nature Reserve; this eliminates the requirement for bridge structures at the northern tunnel portal.

Workshop outcomes

Option 9 scored poorly for constructability due to tunnelling required in very hard rock. Tunnelling has additional design, safety and maintenance requirements that are technically challenging in this terrain. The variable nature of the hard rock presents high risk and construction difficulties which are reflected in the very high cost.
Option 9 scores poorly against the environmental objectives due to the large amount of rock excavated from the tunnel that would need to be transported away from site. Tunnelling also requires a large amount of water and therefore tunnelling activities may impact on surface water quality due to the requirement for extensive wastewater ponds.

Overall, Option 9 scored poorly against the majority of the objectives and was not shortlisted to be taken forward for further investigation and design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	• Reduced crash rate and injuries • Improved road safety standards – improved geometry standard • Minimise conflict points on the highway (intersections) • Constructability • Work Health and safety in construction and maintenance.	6 (equal)	• Road safety would be improved with the vertical and horizontal alignment to improved geometry standards • Scores poorly for constructability and work health and safety in construction and maintenance due to tunnelling in hard rock.
Improve road transport productivity efficiency and reliability of travel	• Reduced road freight user costs • Reduced travel time • Target a route level of service of A • Increase road network capacity.	1 (equal)	• The alignment has conforming horizontal and vertical geometry. Scores higher than other conforming alignments with minimum radius curves.
Minimise the impact on the natural, cultural and built environment	• Impact on fauna habitat including threatened species • Impact on flora including threatened species • Water quality • Air quality • Noise and vibration impact • Aboriginal and non-Aboriginal heritage • Stormwater and drainage • Residential and commercial properties impacted • Ecological sustainability • Visual impact and amenity.	7 (equal)	• Scores poorly for impacts to flora and fauna as the route passes through the Bolivia Hill Nature Reserve • Scores well for non-Aboriginal heritage as it avoids most areas of sensitivity (small impact in a small area along the rail line) • Scores well for Aboriginal heritage as it avoids highly sensitive land and only impacts a small portion of moderate sensitivity • Scores well in regard to surface water quality as it avoids the existing hydrology constraints, however construction activities may impact on surface water quality • Scores well as this option avoids the existing watercourse • Scores poorly on potential to use recycled or waste material due to the large amount of rock excavated from the tunnel that would need to be transported away from site.
Provide value for money	• Cost benefit ratios • NPV over 30 years • Road user costs and benefits • Infrastructure operating costs (including maintenance) • Comparative project costs.	8 (equal)	• Cost $890 M • $761 M more than lowest cost option due to the very high cost of tunnelling through hard rock • Cost is considered excessive.

Option 10

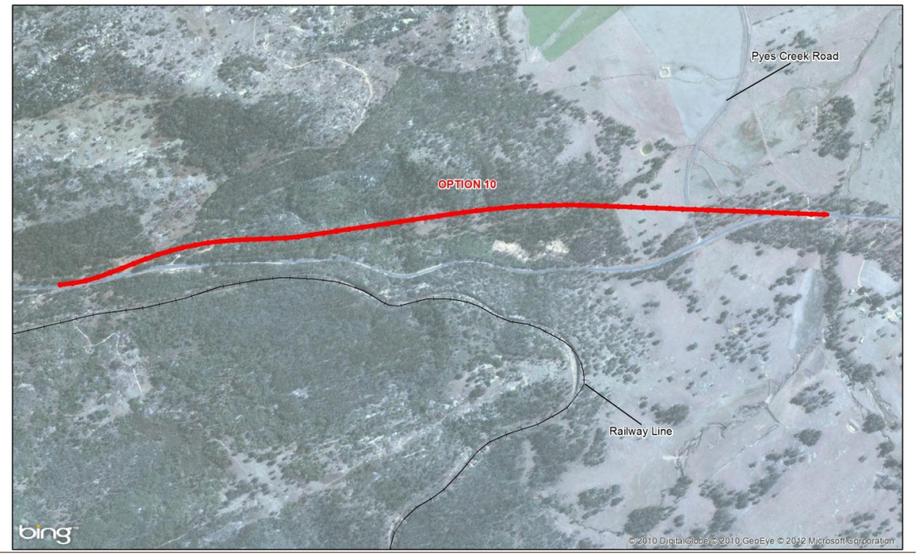
Option 10 is a variant to Option 3 where it attempts to follow the ridgeline to the west of the existing highway while trying to avoid impact to the creek, and also considerably reducing the overall length of bridge required.

Workshop outcomes

Option 10 has an acceptable score for constructability due to a shallower cutting in very hard rock compared to other options with large cuts. Option 10 scored reasonably well against the environmental objectives due to its smaller footprint having a smaller impact on flora and fauna. The cost of the option was large due to the requirement for a very long bridge/viaduct required to minimise the impact on the creek to the west of the existing highway.

Overall, Option 10 scored well against the majority of the objectives and the workshop participants considered that it should be investigated in the next stage of design.

Note – Overall Ranking Against Objective – 1 equals best, 11 equals worst



Project Objectives	Critical Criteria	Overall Ranking Against Objective	Comment
Improve road safety	• Reduced crash rate and injuries • Improved road safety standards – improved geometry standard • Minimise conflict points on the highway (intersections) • Constructability • Work Health and safety in construction and maintenance.	1 (equal)	• Road safety would be improved with the vertical and horizontal alignment to improved geometry standards • Acceptable score for constructability and work health and safety in construction and maintenance due to no major cut in hard rock.
Improve road transport productivity efficiency and reliability of travel	• Reduced road freight user costs • Reduced travel time • Target a route level of service of A • Increase road network capacity.	5 (equal)	• Although the alignment has conforming horizontal and vertical geometry, scores poorly in comparison with other options due to the use of minimum radius curves.
Minimise the impact on the natural, cultural and built environment	• Impact on fauna habitat including threatened species • Impact on flora including threatened species • Water quality • Air quality • Noise and vibration impact • Aboriginal and non-Aboriginal heritage • Stormwater and drainage • Residential and commercial properties impacted • Ecological sustainability • Visual impact and amenity.	5	• Scores well on the impact to flora and fauna as it avoids the Bolivia Hill Nature Reserve and has a smaller area of cut in comparison to other options, but the route would still require removal of some vegetation • Scores well for non-Aboriginal impacts as it avoids most of the sensitive areas, only a small portion in Bolivia Station would be affected by the route • Scores poorly for Aboriginal heritage as the route passes through a large area of high Aboriginal sensitivity along the 100yr ARI floodline • Scores poorly in relation to surface water quality due to interference with existing creek alignment and floodplain • The proposed viaduct results in a poor score for flooding and drainage due to the potential for piers and foundations to impact on existing hydrology • Scores well for recycling of waste material as the rock cut can be used in fill on site.
Provide value for money	• Cost benefit ratios • NPV over 30 years • Road user costs and benefits • Infrastructure operating costs (including maintenance) • Comparative project costs.	3 (equal)	• Cost $362 M • $233 M more than lowest cost option mainly due to the major bridge/viaduct.

Table 7-3 Summary of initial assessment of list of options against project objectives and assessment criteria

Project Objectives	Critical Criteria*[1]	Description of criteria that can be assessed	1	2	3	4	5a	5b	6	7	8	9	10
Improve road safety	• Reduced crash rate and injuries • Improved road safety standards – improved geometry standard • Minimise conflict points on the highway (intersections) • Constructability • Work health and safety in construction and maintenance.	• Provide for an overtaking lane for southbound traffic and possibly a dual lane carriageway separated by wire rope.	4	4	4	4	4	4	4	3	4	4	4
		• Provide an alignment that minimises problems in construction.	1	2	3	3	1	1	3	1	1	1	3
		• Maintain at least one lane of the highway open during construction of the upgrade.	4	4	4	4	4	4	4	3	4	4	4
		• Minimise work health and safety risk in construction and maintenance.	2	3	3	3	2	2	3	1	2	2	3
		Total for road safety	**11**	**13**	**14**	**14**	**11**	**11**	**14**	**8**	**11**	**11**	**14**
Improve road transport productivity efficiency and reliability of travel	• Reduced road freight user costs • Reduced travel time • Target a route level of service of A • Increase road network capacity.	• Provide appropriate horizontal and vertical road geometry.	2	2	2	3	2	3	2	1	2	3	3
		Total for road transport productivity	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**1**	**2**	**3**	**3**
Minimise the impact on the natural, cultural and built environment	• Impact on fauna habitat including threatened species • Impact on flora including threatened species • Water quality • Air quality • Noise and vibration impact • Aboriginal and non-Aboriginal heritage • Stormwater and drainage • Residential and commercial properties impacted • Ecological sustainability • Visual impact and amenity.	• Minimise adverse impacts on native vegetation.	2	3	3	3	1	1	3	3	2	1	3
		• Minimise adverse impacts on sensitive habitats.	2	3	3	3	1	1	3	3	2	1	3
		• Minimise adverse impacts on surface water quality.	2	2	3	3	3	3	3	3	2	3	2
		• Minimise adverse impacts on flooding and drainage.	2	2	2	3	3	3	2	3	2	3	2
		• Minimise adverse impacts on known non-Aboriginal heritage sites, values and areas of archaeological potential.	2	2	1	2	4	4	3	3	2	4	1
		• Minimise adverse impacts on known Aboriginal heritage sites, values and areas of archaeological potential.	3	3	3	3	2	2	4	3	4	3	3
		• Potential to use recycled or waste materials.	1	1	4	2	1	1	3	4	1	1	3
		Total for environment	**14**	**16**	**19**	**19**	**15**	**15**	**21**	**22**	**15**	**16**	**17**
Provide value for money	• Cost benefit ratios • NPV over 30 years • Road user costs and benefits • Infrastructure operating costs (including maintenance) • Comparative project costs.	• Minimise project cost.	0	2	1	1	2	0	3	4	0	0	2
		Total for value for money	**0**	**2**	**1**	**1**	**2**	**0**	**3**	**4**	**0**	**0**	**2**
		Combined Score	**27**	**33**	**36**	**37**	**30**	**29**	**40**	**35**	**28**	**30**	**36**

7.5 Phase 4: Conclusion and next steps

7.5.1 Ranking of options

Table 7-4 and **Table 7-5** are derived from **Table 7-3** and present a summary of the workshop process findings. The first category of routes taken forward to the next stage comprises the routes that best meet the objectives of the project. Routes not taken forward comprise those routes that performed poorly on balance in relation to meeting the project objectives.

Table 7-4 Shortlist of routes

Shortlist of routes	Combined score	Comment
Option 6 (Option 4)	40 (37)	Option 4 considered a variation to Option 6
Option 10 (Option 3)	36 (36)	Option 3 considered a variation to Option 10
Option 7	35	-
Option 2	33	-

Table 7-5 Routes not taken forward

Routes not taken forward	Combined score
Option 1	27
Option 5a	30
Option 5b	29
Option 8	28
Option 9	30

The shortlisted route options in **Table 7-4** were taken forward with some modifications (refer to **Section 7.5.3**) for further analyses and subsequent consideration as the preferred route. These routes are shown in **Figure 7-13** and described in **Chapter 8**.

7.5.2 Assessment of community options

The community options were assessed as follows:

- An alignment to the western side of the study area. This alignment is similar to Option 1 and will therefore not be taken forward
- An alignment to the east of the existing highway along the existing railway alignment. This alignment is similar to Options 5a and 5b and will therefore not be taken forward
- An alignment to the east of the existing highway through Bolivia Hill Nature Reserve. This alignment is similar to Option 9 and will therefore not be taken forward
- The option of adopting the current alignment for uphill (southbound) lanes and a new alignment to the west of the existing alignment for a downhill (northbound) lane was considered. The workshop reached the conclusion that the cost effective solution is to either upgrade the existing alignment to cater for all traffic (such as Option 7 which has been shortlisted to be taken forward) **or** to build a new alignment to cater for all traffic (such as Option 6 or 10 which have also been shortlisted to be taken forward). The combined option will therefore not be taken forward
- An upgrade of the existing alignment (widening). This alignment is similar to Option 7 and will therefore be subject to further analyses and subsequent consideration as the preferred route.

7.5.3 Review of design criteria

Following agreement on the ranking of options, workshop participants expressed concern at the high cost of the shortlisted options.

Participants agreed that consideration should be given to varying some of the design criteria set out by the RMS document *Network Performance Measures and Network Planning Targets, July 2010,* to make any upgrade route more consistent with the usage of the topography. The following conclusions were reached:

- Costs would be substantially reduced if a steeper vertical alignment was adopted – say 7-8 per cent. This would lower the grade line resulting in substantially shorter bridges, smaller retaining walls and smaller fills
- This project should be related to similar projects such as Devils Pinch on the New England Highway south of Glen Innes to refine the criteria and obtain approval from the federal government.

Approval to revised design criteria was obtained from RMS internal experts subsequent to the workshop. The revised criteria are detailed in **Section 6.1.1**.

The traffic study (**Section 2.3.1** and **Appendix A**) established that there is no warrant for a northbound overtaking lane at Bolivia Hill based on the requirements of the *Network Performance Measures and Network Planning Targets, July 2010*. The workshop group agreed that further development of the shortlisted options should therefore be based on a three-lane cross section.

Costs would therefore be reduced from those reported for the options in **Section 7.2** when the revised design criteria are applied and a three-lane cross section is adopted. The revised costs are provided in **Chapter 8**.

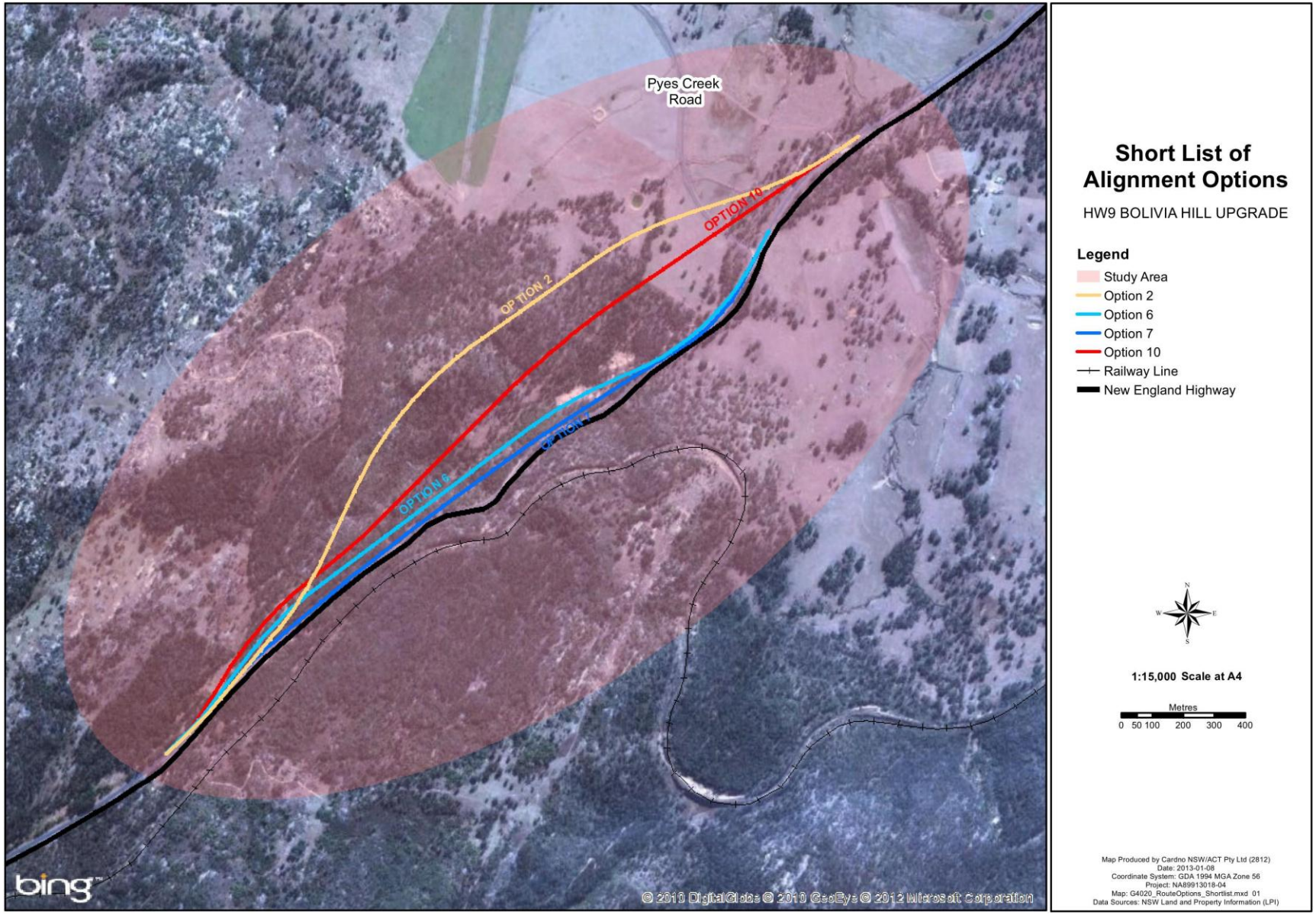


Figure 7-13 Shortlist of route options