M1 Princes Motorway

Interchange at the base of Mount Ousley

Preferred Option Report

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Executive summary

The M1 Princes Motorway is the main road linking Sydney and the Illawarra. More than 44,000 vehicles use the motorway at the base of Mount Ousley near Wollongong each day, with heavy vehicles representing up to 15 per cent of daily vehicle movements.

The importance of Mount Ousley Road and the Princes Motorway as an essential link is highlighted by their inclusion in the National Land Transport Network (NLTN). The intersection of the Princes Motorway and Mount Ousley Road is located about three kilometres north-west of the Wollongong CBD near the University of Wollongong.

The Princes Motorway and Mount Ousley Road provide a vital road link for:

- Commuters travelling between Sydney and the Illawarra region
- Tourist traffic travelling between Sydney, the Illawarra region and the NSW South Coast
- Commuters travelling between Sydney and the University of Wollongong
- Road freight traffic travelling between the Illawarra region (particularly Port Kembla), the South Coast, Sydney and the northern Illawarra collieries.

The Princes Motorway and Mount Ousley Road currently experience heavy traffic congestion particularly during weekday, weekend and holiday peaks. The intersection of these two roads is the only location on the Princes Motorway between Waterfall and Albion Park Rail (a distance of about 60 kilometres) where vehicles turning right to access the motorway need to give way to oncoming motorway traffic. In addition to poor road network performance, 34 crashes were recorded near the intersection during the ten 10 year period between July 2004 and June 2014 (inclusive). Of the 34 crashes, one crash resulted in one fatality and four injuries, and 13 were injury crashes resulting in 23 injuries. Twenty five of the crashes involved vehicles turning right out of Mount Ousley Road onto the Princes Motorway.

The southbound carriageway of the Princes Motorway has a sign-posted speed limit of 80 kilometres per hour for light vehicles and 40 kilometres per hour for heavy vehicles. This speed difference creates conflicts as faster moving light vehicles (travelling in the right lane) are required to cut across groups of slower moving heavy vehicles (travelling in the left lane) to exit at Mount Ousley Road, which is the main access from the north to the Wollongong CBD and surrounding suburbs. Conflicting interactions between light and heavy vehicles also creates road safety risks and contributes to traffic flow breakdowns creating additional congestion in this area. These interactions also reduce the efficiency of access to nearby destinations, such as the Wollongong CBD and the University of Wollongong.

Further south on the Princes Motorway, the southbound morning queue from University Avenue regularly extends back toward the motorway with vehicles accessing the university and surrounds. This creates traffic flow breakdown on the Princes Motorway and increases the risk of crashes as vehicles intending to exit to University Avenue slow down on the motorway. Modelling shows that in the future, these queues will regularly extend back onto the motorway and past the Mount Ousley Road intersection blocking access into Wollongong by this route.

To address the above issues four strategic design options have been developed and are described below. The various options provide similar levels of functionality however Option 4 provides a new exit from the university to the Princes Motorway. All options reduce conflict between light and heavy vehicles and provide:

- An overpass from Mount Ousley Road to the Princes Motorway
- A new access to the University of Wollongong
- Pedestrian and cyclist bridges over Mount Ousley Road and the Princes Motorway connecting suburbs to the north with the University

- Provision for a future third southbound lane.

The options vary in relation to connectivity between the Princes Motorway and the university, traffic and safety gains, capital cost and economic performance. A short description of each option is provided below.

Option 1:

- Separated light vehicle and heavy vehicle lanes for accessing Mount Ousley Road from the Princes Motorway southbound. The light vehicle lane would be an overpass from the right lane of the Princes Motorway to Mount Ousley Road.
- An overpass lane from Mount Ousley Road to the Princes Motorway northbound
- An additional entry access to the University of Wollongong.

Option 2:

- Separated light vehicle and heavy vehicle lanes for accessing Mount Ousley Road from the Princes Motorway southbound. The light vehicle lane would be an overpass from the right lane of the Princes Motorway to Mount Ousley Road and a loop road would enable vehicles to access the University of Wollongong from the north at the interchange
- An overpass lane from Mount Ousley Road to the Princes Motorway northbound
- An additional entry access to the University of Wollongong.

Option 3:

- Separated heavy vehicle bypass lanes to access Mount Ousley Road or travel under Mount Ousley Road and merge back onto M1 Princes Motorway southbound
- An overpass lane from Mount Ousley Road to the Princes Motorway northbound
- An additional entry access to the University of Wollongong.

Option 4:

- Separated eastbound heavy vehicle bypass lanes to access Mount Ousley Road or travel under Mount Ousley Road and merge back onto M1 Princes Motorway in the south
- An overpass lane from Mount Ousley Road to the Princes Motorway northbound
- An additional roundabout entry access to the University of Wollongong
- An additional exit from the University of Wollongong to the Princes Motorway north and Mount Ousley Road.

Option 4 has been selected as the preferred option as it provides a value for money solution that best addresses the traffic and safety issues on the Princes Motorway and nearby intersections. Option 4 also provides an exit from the university onto the Princes Motorway reducing congestion within the university and surrounding local road network particularly in the afternoon peak. This option can largely be constructed offline providing safety and traffic management advantages during construction. Option 4 was selected by all who attended the Value Management Workshop in December 2015, which included key external stakeholders including the University of Wollongong and Wollongong City Council, as the option to progress for further development.

Contents

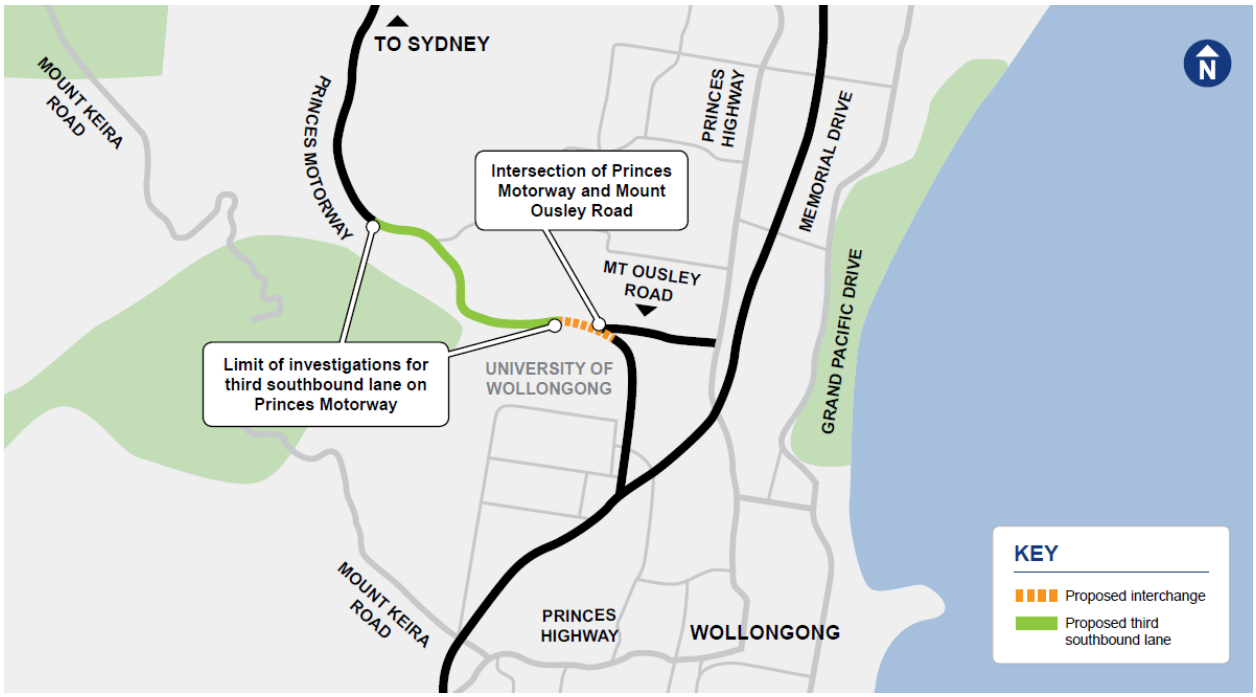
Background

The M1 Princes Motorway is the main road link between Sydney and the Illawarra, with average daily traffic of more than 44,000 vehicles using this link at the base of Mount Ousley near Wollongong. Heavy vehicles represent up to 15 per cent of total daily vehicle movements. The importance of Mount Ousley Road and the Princes Motorway and their strategic significance as an essential link for freight and passengers is illustrated by their inclusion in the National Land Transport Network (NLTN).

The Princes Motorway and Mount Ousley Road provide a vital road link for:

- Commuters travelling between Sydney and the Illawarra region
- Tourist traffic travelling between Sydney, the Illawarra region and the NSW South Coast
- Commuters travelling between Sydney and the University of Wollongong
- Road freight traffic travelling between the Illawarra region (particularly Port Kembla), the South Coast, Sydney and the northern Illawarra collieries.

The importance of the Princes Motorway and Mount Ousley Road to the Illawarra region has been identified in a number of State Government strategic planning documents, which include the NSW Long Term Transport Master Plan, the NSW Ports and Freight Strategy, the Sydney-Wollongong Corridor Strategy and the Illawarra Regional Strategy.



Location of proposed interchange at Mount Ousley Road and future third southbound lane

The Princes Motorway and Mount Ousley Road are currently subject to heavy traffic congestion, particularly during weekday, weekend and holiday peaks.

The southbound carriageway of the motorway has a sign-posted speed limit of 80 kilometres per hour for light vehicles and 40 kilometres per hour for heavy vehicles (trucks and buses). This speed difference creates conflicts as faster moving light vehicles (travelling in the right lane) are required to cut across groups of slower moving heavy vehicles (travelling in the kerbside lane) to exit at Mount Ousley Road which is the primary access from the north to the Wollongong CBD and surrounding suburbs. Conflicting interactions between light and heavy vehicles also creates road

safety risks and contributes to traffic flow breakdowns (stop-start or acceleration and braking) which impacts on the efficiency of the network in this area. In turn this reduces the efficiency of access to nearby destinations, such as the Wollongong CBD and University of Wollongong.

Further south on the Princes Motorway, the southbound morning queue from University Avenue regularly extends back toward the motorway with vehicles going to the university and surrounds. This also creates traffic flow breakdown on the motorway and increases the risk of crashes as vehicles intending to exit to University Avenue slow down on the motorway. Modelling shows that in the future model years, these queues will regularly extend back onto the Princes Motorway in peak hours and past the Mount Ousley Road intersection blocking access into Wollongong.

The Princes Motorway and Mount Ousley Road intersection is currently an at-grade priority controlled T-intersection, with vehicles on the motorway having priority over other vehicles entering via Mount Ousley Road. The current layout of the intersection is shown below, with vehicles from Mount Ousley Road able to turn right to enter the motorway to travel northbound by crossing the two southbound lanes of the motorway.

The intersection is the only location on the Princes Motorway between Waterfall and Albion Park Rail (a distance of about 60 kilometres) where vehicles are permitted to make an at-grade right-turn to access the Princes Motorway.

The intersection of the Princes Motorway with Mount Ousley Road for southbound traffic is at the end of a long steep descent, with grades typically around eight percent (and up to 10 percent), prior to the motorway flattening out in the vicinity of the intersection.

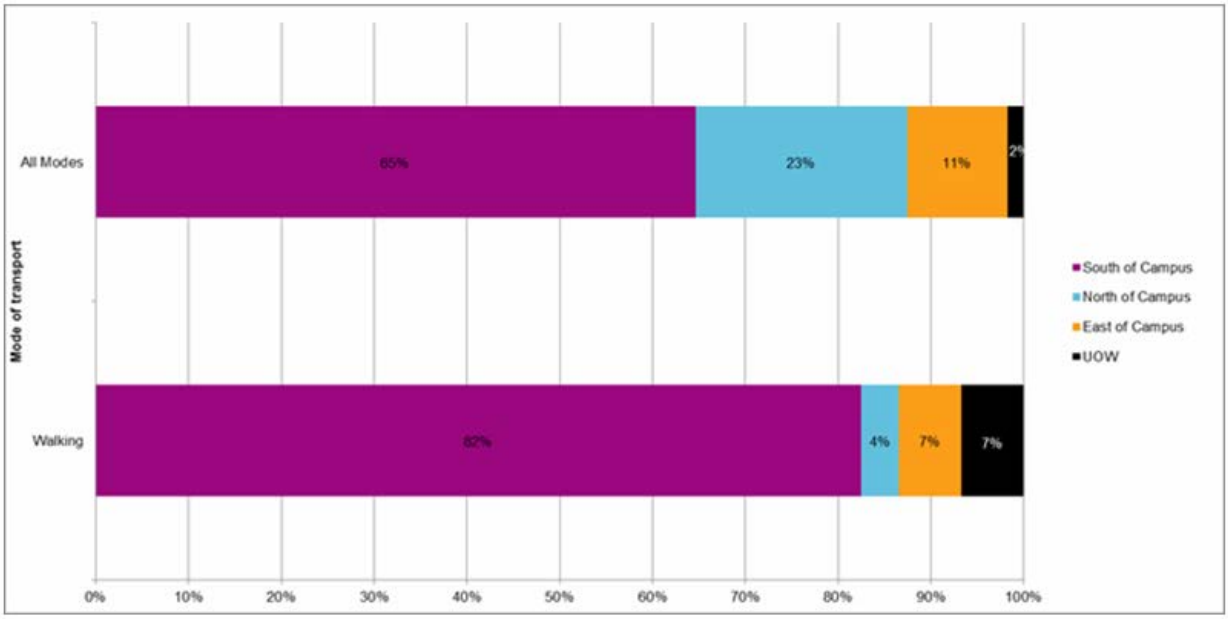
This intersection currently operates at a Level of Service (LoS) F with an average delay of 120 seconds in the morning peak and 70 seconds in the afternoon peak. The traffic delay of the right turn movement is predicted to increase by up to 50 seconds in the morning peak and 65 seconds in the afternoon peak between 2015 and 2041 as a result of traffic growth on the Princes Motorway.

Looking east at the queue of vehicles on Mount Ousley Road waiting to turn right onto the Princes Motorway

In addition to poor road network performance, 34 crashes were recorded near the intersection during the ten year reporting period between July 2004 and June 2014 (inclusive). Of the 34 crashes, one was a fatal crash resulting in one fatality and four injuries, 13 were injury crashes that resulted in 23 injuries and 20 were non-casualty crashes. Twenty five of the crashes involved vehicles turning right out of Mount Ousley Road onto the Princes Motorway, which is proposed for grade separation.

The Princes Motorway creates a barrier for safe pedestrian and cyclist movements between the University of Wollongong and suburbs to the north. The graph below shows that within three

kilometres of the university, 23 percent of students live to the north of the campus however only four percent of people that walk to the university come from suburbs to the north.



Source: AECOM; 2015, modified from UOW; 2015

Mode of transport to UOW by location within three kilometres of the University of Wollongong

Options review

In response to the identified problems, Roads and Maritime has developed a range of strategic options. The identified problems proposed to be addressed are:

1. Safety of the at-grade right turn from Mount Ousley Road onto the Princes Motorway
2. Traffic congestion at University Avenue interchange and flow on impacts to the Princes Motorway
3. Weave conflict between southbound trucks in the kerbside (slow lane) on the Princes Motorway and vehicles exiting at Mount Ousley Road
4. Safety of pedestrian and cyclist connections between the University of Wollongong and suburbs to the north
5. Southbound traffic capacity.

Traffic at the University Avenue interchange extending back onto the Princes Motorway

Each of these identified problems has an associated treatment which is incorporated into the strategic options. The treatments being developed are:

1. Grade separate the right turn from Mount Ousley Road onto the Princes Motorway
2. Additional access to the University of Wollongong as part of the grade separated interchange
3. A truck bypass of the intersection with Mount Ousley Road or a light vehicle overpass exit to eliminate the current weave conflict at Mount Ousley Road
4. Pedestrian and cyclist bridges over Mount Ousley Road and the Princes Motorway connecting to the University of Wollongong
5. A future third southbound lane on the Princes Motorway from the existing southbound arrestor bed to the junction with Mount Ousley Road.

Heavy vehicles are required to use the left lane and travel at a reduced speed limit of 40 kilometres per hour compared with the 80 kilometres per hour speed limit for all other vehicles. As many of these heavy vehicles continue south on the motorway past the exit to Mount Ousley Road, the weave conflict is created with light vehicles wishing to exit at Mount Ousley Road. As noted earlier, heavy vehicles currently account for up to 15 per cent of daily vehicle movements and with the forecast increase in the freight task, they will represent a growing proportion of all vehicles operating along the motorway.

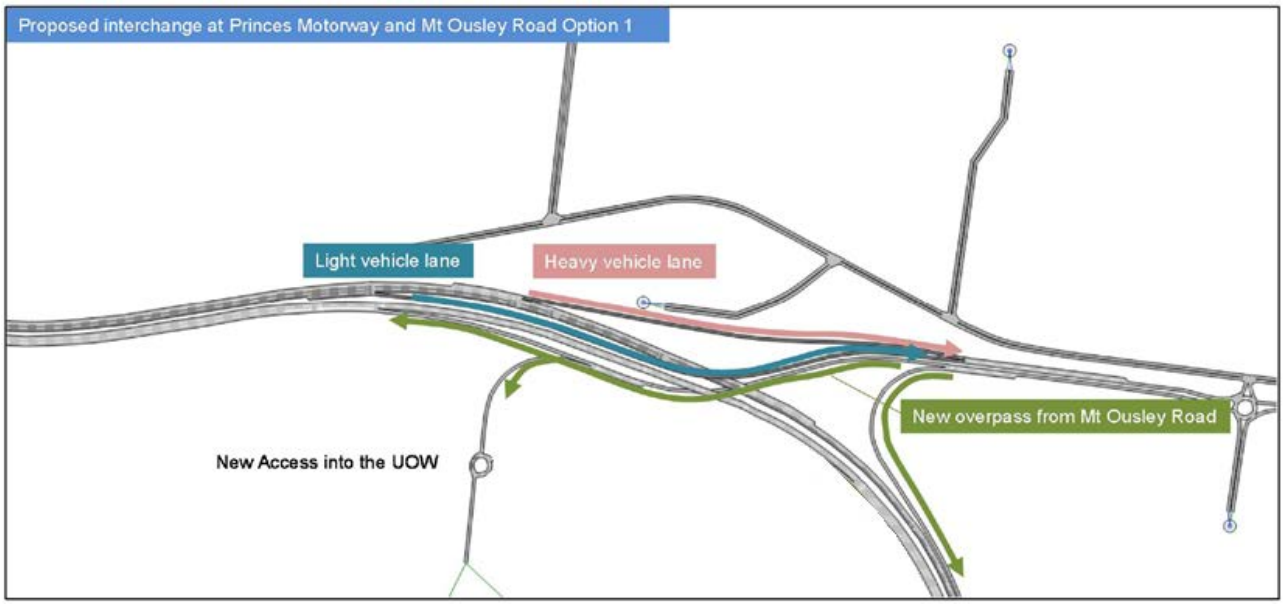
The traffic modelling undertaken as part of the options development process suggests that the combination of growth in vehicle numbers and the speed difference between heavy and light

vehicles will mean there are substantially reduced gaps in the left kerbside lane for vehicles wishing to exit to Mount Ousley Road. This problem is exacerbated over time in the modelling as volumes increase.

To address the above issues four strategic design options have been developed and are shown below. The various options provide similar levels of functionality however Option 4 provides a new exit from the university to the motorway. Importantly all provide for grade separation of the right turn from Mount Ousley Road to the motorway, a new access to the university, pedestrian and cyclist bridges over Mount Ousley Road and the Princes Motorway which connect suburbs to the north with the university, and provision for a future third southbound lane. The options vary in relation to connectivity between the motorway and the university, traffic and safety gains, capital cost and economic performance.

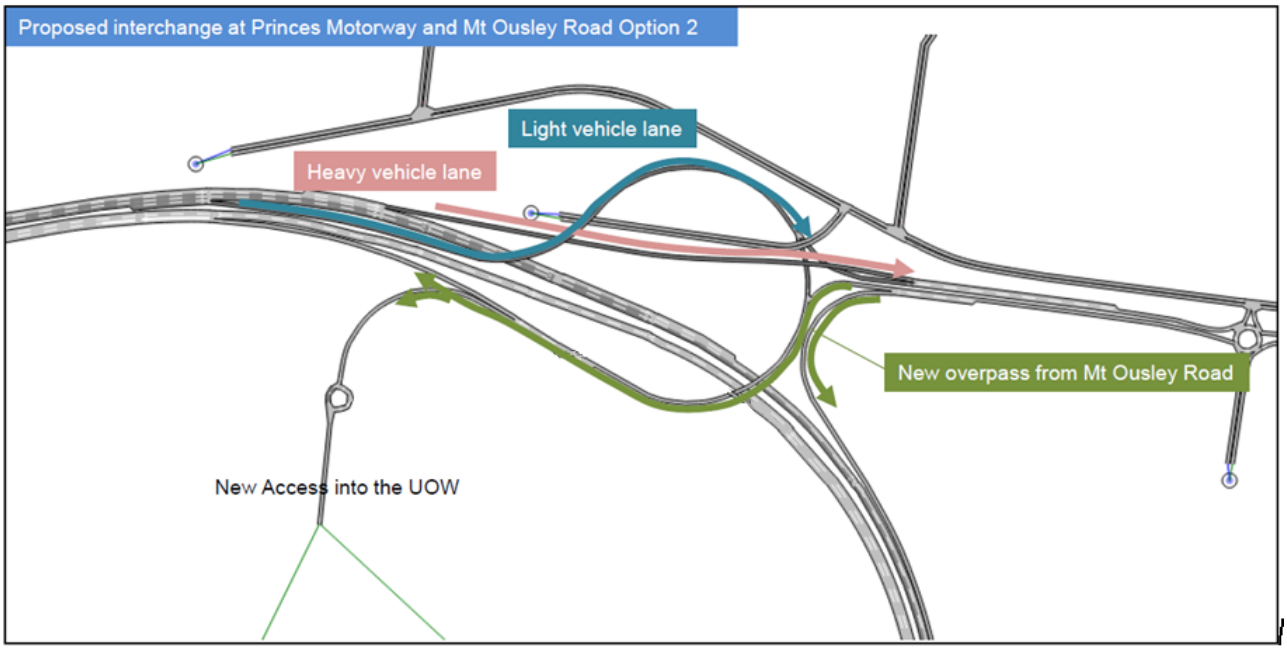
Option 1:

- Separated light vehicle and heavy vehicle lanes for accessing Mount Ousley Road from the Princes Motorway southbound. The light vehicle lane would be an overpass from the right lane of the Princes Motorway to Mount Ousley Road.
- An overpass lane from Mount Ousley Road to the Princes Motorway northbound
- An additional entry access to the University of Wollongong.



Option 2:

- Separated light vehicle and heavy vehicle lanes for accessing Mount Ousley Road from the Princes Motorway southbound. The light vehicle lane would be an overpass from the right lane of the Princes Motorway to Mount Ousley Road and a loop alignment would enable vehicles to access the University of Wollongong from the north at the interchange
- An overpass lane from Mount Ousley Road to the Princes Motorway northbound
- An additional entry access to the University of Wollongong.



Option 3:

- Separated heavy vehicle bypass lanes to access Mount Ousley Road or travel under Mount Ousley Road and merge back onto M1 Princes Motorway southbound
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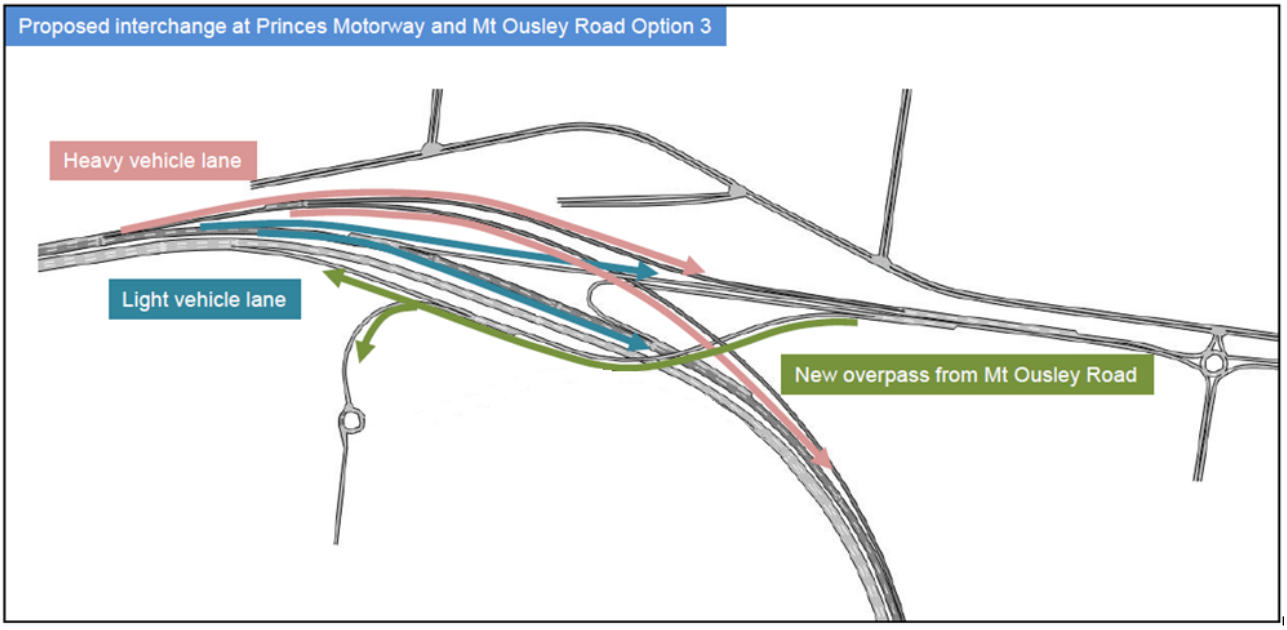
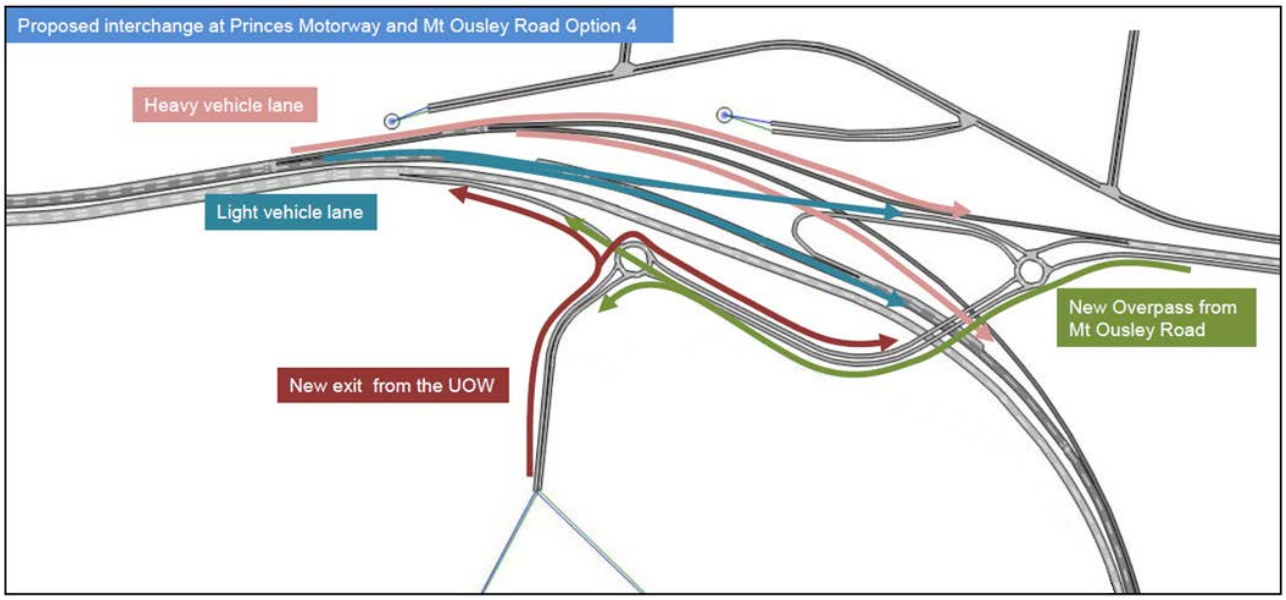


Option 4:

- Separated eastbound heavy vehicle bypass lanes to access Mount Ousley Road or travel under Mount Ousley Road and merge back onto M1 Princes Motorway in the south
- An overpass lane from Mount Ousley Road to the Princes Motorway northbound
- An additional roundabout entry access to the University of Wollongong
- An additional exit from the University of Wollongong to the Princes Motorway north and Mount Ousley Road.



Each of the four options developed improves the safety and efficiency of the Princes Motorway and connecting roads such as Mount Ousley Road and University Avenue. The improved operation of the road network can support the University of Wollongong's transport strategies, which relate to public and active transport solutions for the commute to and from the university. Specifically, the pedestrian and cyclist bridge across the motorway connects the suburbs of Mount Ousley, Fairy Meadow and suburbs further north with the University of Wollongong. In addition, the improved network efficiency and safety could encourage further improvements for public transport access to the university.

Other options considered

In addition to the above options, two low cost options were considered. One option was to ban the right turn from Mount Ousley Road which would eliminate the crashes associated with that movement which included the fatal crash. The other option was to grade separate the right turn movement from Mount Ousley Road to the Princes Motorway and to signalise the roundabouts of the University Avenue interchange with queue detection in order to manage queues at the interchange and reduce their impact on the motorway.

Ban right turn option:

Due to increasing volumes on the Princes Motorway in future years, it was predicted in the traffic modelling that less vehicles would use the right turn movement from Mount Ousley Road due to increasing delays. Therefore, the right turn ban was predicted to have minimal quantitative impact on the network due to the low traffic demands as excessive delays would be likely to redirect

vehicles to other routes such as the Princes Highway and the Memorial Drive loop to access the Princes Motorway northbound.

This ban would improve safety at the intersection however it would not address the greater network traffic congestion mainly associated with the University Avenue interchange and its impacts on the operation of the motorway. It also would not address conflicts between light vehicles exiting to Mount Ousley Road and heavy vehicles continuing on the motorway.

In the ban right turn scenario, traffic would be redirected to the Memorial Drive loop to access the Princes Motorway northbound. This would place increased pressure on the weave on Memorial Drive towards the Princes Motorway exit ramp, which operates with a distance of 450 metres between ramps across two through lanes as shown below. At this location there are also vehicles exiting from Memorial Drive to the left at the Porter Street exit.

Weave movements on Memorial Drive

Low cost option:

This option would include grade separating the right turn from Mount Ousley Road onto the Princes Motorway and signalising the roundabouts on the University Avenue interchange with queue detection on the ramps to manage queues and their impact on the operation of the motorway.

The fixed time traffic signal at University Avenue roundabout would distribute the green time based on the traffic volumes on the southbound right turn lane and the opposing eastbound trips on University Avenue.

The modelling showed that the traffic signal control would reduce the queuing and the delay on the southbound off ramp to University Avenue by up to one minute, however, the queuing and traffic delays on the northbound off ramp increased substantially by over four minutes which in turn impacted on the Memorial Drive loop to the Princes Motorway. This demonstrates that this measure would not be effective even in 2021.

This reflects the issues in trying to balance queues at the interchange in an attempt to maintain traffic flow on the motorway. These issues are faced by traffic controllers which are employed to manage flows at the University Avenue interchange for the first four weeks of semester. As one ramp of the interchange is allowed to flow to clear the queue on that ramp, a resulting queue forms on the other ramp.

The overall improvements to the network as a result of the low cost option are minimal with no reduction in average vehicle delay. As the low cost option did not achieve satisfactory improvements to the network it has not been considered further.

The preferred option:

Option 4 has been selected as the preferred option as it provides a value for money solution that best addresses the traffic and safety issues on the motorway and adjacent intersections. It has the added benefit of an exit from the university onto the motorway, reducing congestion within the university and surrounding local road network particularly in the afternon peak. Option 4 can also largely be constructed offline providing safety and traffic management advantages during construction. Option 4 was selected by all who attended a Value Management Workshop held in December 2015, which included key external stakeholders including the University of Wollongong and Wollongong City Council, as the option to progress for futher development.

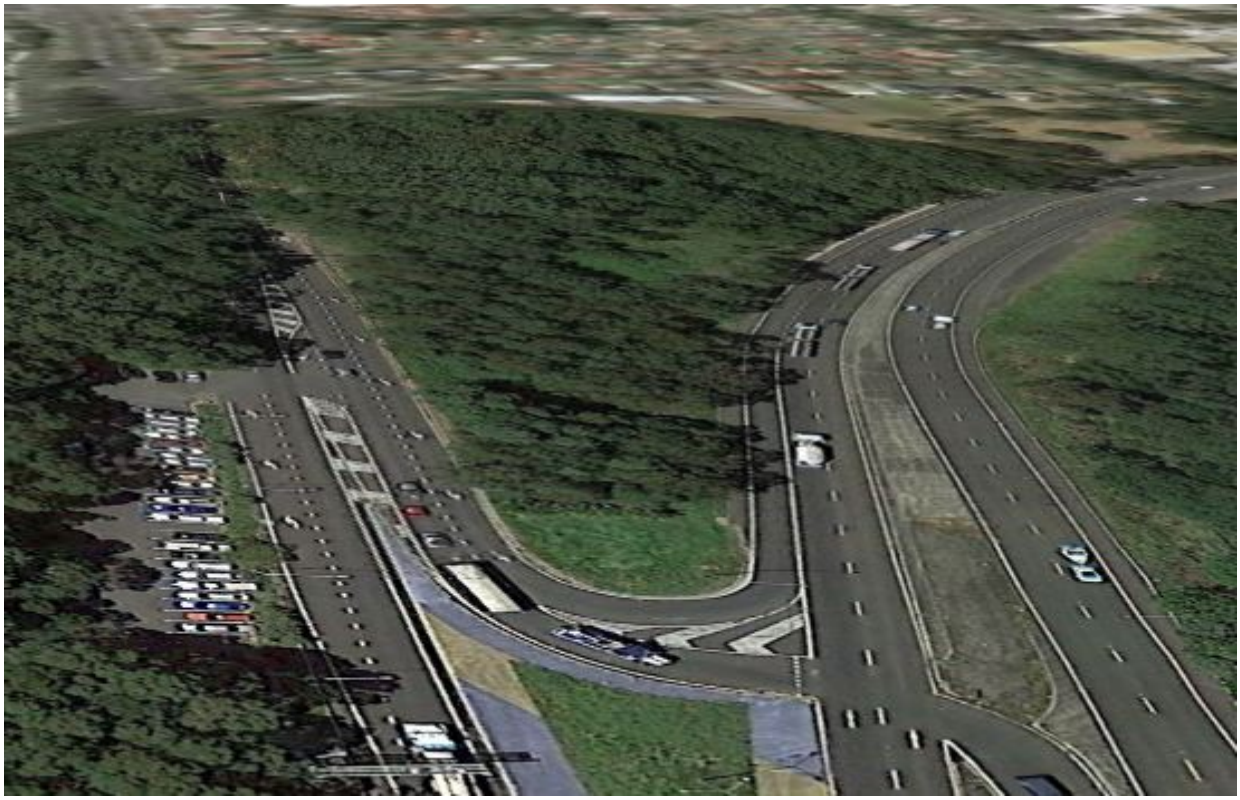
Further refinements to determine the best location for a new commuter car park and pedestrian and cyclist connections across the motorway are being considered in consultation with the community.

Four viewpoints of the preferred option are provided below. It should be noted that these are early draft visuals and features such as landscaping and noise walls are yet to be determined.

Before: aerial view of the existing intersection

After: aerial view of proposed interchange with Option 1 for the relocated commuter carpark

After: aerial view of proposed interchange with Option 2 for the relocated commuter carpark



Before and after: Aerial view looking east toward Mount Ousley Road to the Princes Motorway.

Before and after: View from the southbound carriageway of the Princes Motorway looking east toward Mount Ousley Road. The proposed truck bypass and relocated heavy vehicle safety ramp are located to the left of the image.

Before and After: View from the northbound carriageway of the Princes Motorway towards the proposed overpass from Mount Ousley Road to the Princes Motorway northbound.

Considerations

Property

All interchange options would require property acquisition from the University of Wollongong. No private residential properties would be directly impacted by any of the options. While Option 4 requires the greatest amount of property acquisition from the university, about 1.5 hectares, the university is supportive of this option. As development of the preferred option progresses the final areas required for acquisition from the university would be determined and negotiations would continue.

Traffic

The intersection of Mount Ousley Road and the Princes Motorway currently operates at a LOS F with an average delay of 117 seconds in the morning peak and 111 seconds in the afternoon peak. Many vehicles avoid using the right turn at the intersection due to lengthy delays and safety risks. Instead motorists use alternative routes such as the Memorial Drive loop or the University Avenue interchange depending on time of day and delays experienced on the alternative routes.

Delays in the morning peak at this intersection are predicted to increase to 140 seconds in 2021 and 170 seconds in 2031 despite a reduction in vehicles making this manoeuvre. Groups of slow moving heavy vehicles in the kerbside lane of the motorway also limit sight distance to faster moving light vehicles in the right lane resulting in an increase in gap acceptance impacting on the operation of the intersection.

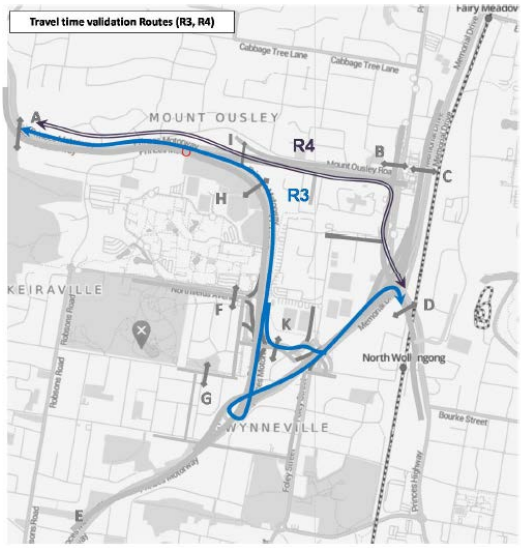
The University Avenue interchange also operates at a LOS F with lengthy delays and queues extending back onto the motorway during peak periods. The University of Wollongong is a significant traffic generator with an average of 1660 vehicles entering the university during the morning peak with a strong peak prior to the first morning lecture. This figure does not include traffic that parks in local roads surrounding the university, a large proportion of which would travel through the University Avenue interchange. During the first four weeks of the university semester, Roads and Maritime employs traffic control to manage demands and queues at the roundabouts of the University Avenue interchange to ensure the efficiency of the motorway.

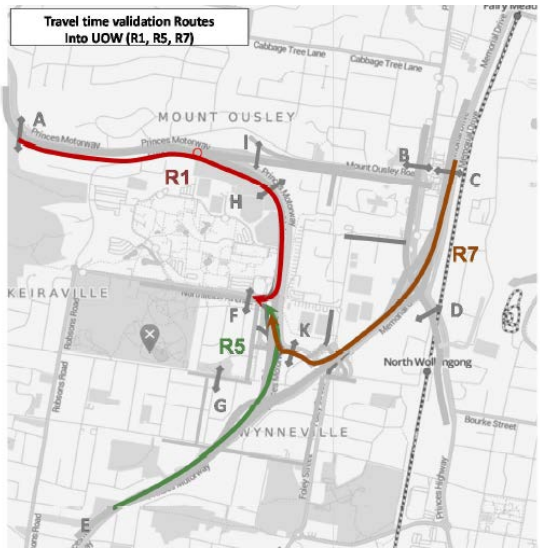
The predicted traffic growth is shown below

- Light vehicle class was estimated to have an annual growth rate of 1.2 per cent from 2015 to 2021, and 1.0% to 2041. This adds up to a 29.5 per cent increase between year 2015 and 2041.
- Heavy vehicle class was estimated to have an annual growth rate of 2.9 per cent from 2015 to 2021, and 1.8 per cent to 2031. This adds up to a 59.0 per cent increase between year 2015 and 2041.
- University traffic is estimated to have a lower annual growth rate of 0.4 per cent throughout the analysis period due to university initiatives to increase on site student accommodation and use of public transport, walking, and cycling modes.

Source Parsons Brinckerhoff (2015)

Travel times on key travel routes through the study area are predicted to increase substantially as shown in the following tables in the do minimum scenarios.





Strategic travel time routes (minutes)	2015 8.00–9.00 am	2021 8.00–9.00 am	2031 8.00–9.00 am	2041 8.00–9.00 am
Route 3 Northbound From Princes Highway south to Princes Motorway north via Memorial Drive ramp	5.4	5.7	5.7	6.0
Route 4 Southbound From Princes Motorway north to Princes Highway south via Mt Ousley Road	5.5	7.6	9.8	13.7

UoW travel time routes (minutes)	2015 8.00–9.00 am	2021 8.00–9.00 am	2031 8.00–9.00 am	2041 8.00–9.00 am
Route 1 Southbound From Princes Motorway north to UoW	12.1	11.0	18.3	21.1
Route 5 Northbound From Princes Motorway south to UoW	1.9	2.2	2.3	2.9
Route 7 Southbound From Memorial Drive north to UoW	3.3	3.8	4.0	4.1

Option 4 which consists of a grade separated interchange at Mount Ousley Road with a new access into the university and a truck bypass achieves substantial network improvements with up to an 11 per cent reduction in vehicle hours travelled (VHT) and 31 per cent reduction in average vehicle delay by 2041 in the morning peak. In the afternoon peak Option 4 achieves a 17 per cent reduction in VHT and 40 per cent reduction in average delay by 2041.

The increases in vehicle kilometres travelled (VKT) are as a result of more vehicles being able to travel through the area as a result of decreased congestion.

Performance indicators (all veh classes)	Diff 2021 7.00–9.00 am	Diff% 2021 7.00–9.00 am	Diff 2031 7.00–9.00 am	Diff% 2031 7.00–9.00 am	Diff 2041 7.00–9.00 am	Diff% 2041 7.00–9.00 am
Total network vehicle throughput (1 hour)	+420	+2%	+970	+3%	+1,810	+6%
Total vehicle kilometre travelled (VKT)	+400	0%	+2,620	+3%	+6,210	+6%
Total vehicle hour travelled (VHT)	-150	-8%	-210	-10%	-250	-11%
Average vehicle speed (km/h)	+2	+4%	+2	+5%	+3	+6%
Average vehicle delay (seconds/km)	-6	-22%	-9	-28%	-12	-31%

Performance indicators (all veh classes)	Diff 2021 4.00–6.00 pm	Diff% 2021 4.00–6.00 pm	Diff 2031 4.00–6.00 pm	Diff% 2031 4.00–6.00 pm	Diff 2031 4.00–6.00 pm	Diff% 2031 4.00–6.00 pm
Total network vehicle throughput (1 hour)	+780	+3%	+1,290	+4%	+2,520	+7%
Total vehicle kilometre travelled (VKT)	+1,970	+2%	+3,960	+4%	+9,260	+8%
Total vehicle hour travelled (VHT)	-360	-15%	-490	-18%	-550	-17%
Average vehicle speed (km/h)	+5	+11%	+5	+12%	+6	+14%
Average vehicle delay (seconds/km)	-12	-33%	-22	-43%	-26	-40%

Substantial travel time reductions of up to eight minutes and almost 15 minutes for the key affected routes from the Princes Motorway north to the Wollongong CBD and University of Wollongong respectively are also achieved in Option 4 in the morning peak by 2041. The travel time savings while less signficant in the afternoon peak are still important.

Strategic travel time routes (minutes) 8.00–9.00 am	Diff 2021	Diff 2031	Diff 2041
Route 3 Northbound From Princes Highway south to Princes Motorway north via Memorial Drive ramp	0	0	0
Route 4 Southbound From Princes Motorway north to Princes Highway south via Mt Ousley Road	-2.2	-4.3	-8.0
Route 1 Southbound From Princes Motorway north to UoW	-6.4	-12.6	-14.8
Route 5 Northbound From Princes Motorway south to UoW	-0.3	-0.3	-0.9
Route 7 Southbound From Memorial Drive north to UoW	-0.6	-0.6	-0.3

Strategic travel time routes (minutes) 5.00–9.00 am	Diff 2021	Diff 2031	Diff 2041
Route 3 Northbound **From Princes Highway south to Princes Motorway north via Memorial Drive ramp**	-0.2	-0.3	-0.7
Route 4 Southbound **From Princes Motorway north to Princes Highway south via Mt Ousley Road**	-0.8	-2.9	-2.6
Route 1 Northbound **From UoW to Princes Motorway north**	-0.5	-0.6	-1.4
Route 5 Southbound **From UoW to Princes Motorway south**	-0.7	-0.9	-0.7
Route 7 Northbound **From UoW to Memorial Drive north**	-0.7	-1.1	-1.8

Road Safety

A detailed crash analysis was undertaken for the 10-year period from July 2004 to June 2014. This analysis shows 34 crashes were recorded near the intersection during the ten year reporting period as shown in the figure below. Of the 34 crashes, one was a fatal crash resulting in one fatality and four injuries, 13 were injury crashes that resulted in 23 injuries and 20 were non-casualty crashes. Twenty five of the crashes involved vehicles turning right out of Mount Ousley Road onto the motorway.

The *Safe System* approach was officially endorsed by the Australian Transport Council and has been adopted by all Australian state and territory road authorities, including NSW. The *Safe System* approach to road safety recognises that mistakes will be made by drivers. However, the cost of driver error and vehicle crashes should not be death or life disabling injury on the roads.

In the context of a *Safe System* approach, the need to remove the current at-grade connection is clear. The only recorded fatality in the past decade was at this location. Intersection crashes involving vehicles from adjacent approaches are one of the most dangerous crash-types (behind being hit by a train and head-on crashes). The grouping of heavy vehicles and queuing at the University Avenue interchange present growing risks to road safety in the study area if action is not taken.

Location of crashes at the Mount Ousley Road and Princes Motorway intersection (2004-2014)

Option 4 would grade separate the right turn movement from Mount Ousley Road to the Princes Motorway to eliminate the crashes associated with that movement. Option 4 would also include a truck bypass which would reduce the conflicts between light vehicles trying to access Wollongong at Mount Ousley Road and heavy vehicles continuing south on the motorway. In addition, a new and improved heavy vehicle safety ramp would be built as part of the interchange.

Following the proposed truck bypass, heavy vehicles continuing south on the motorway would need to merge back onto the motorway before the University Avenue interchange over a distance of 490 metres. As the proposed interchange would take a substantial proportion of southbound university traffic away from the University Avenue interchange, there would be reduced traffic in this merge zone and queues would be contained within the ramp length and would not reduce the distance available to complete the merge.

To analyse the safety and efficiency of this merge a weave analysis was undertaken based on the *Highway Capacity Manual (2010)* which takes into account the number and type of vehicles changing lanes in a road segment, the distance available to complete the lane change, and the range of speeds vehicles could be travelling at.

The analysis found that the section of motorway between the truck bypass and the University Avenue interchange would operate at a LoS B in 2021 and LoS C in 2041. Level of Service is the perceived quality of a road or transport service and is often represented in a six-bin system from A to F, where A is the best and F is the worst, and the generally acceptable LoS is between C and D (Austroads 2015). This shows that the truck bypass and merge back onto the motorway can operate with an acceptable LoS well into the future.

Utilities

Dial before you dig surveys have indicated that underground power is located within the vicinity of the proposed interchange. Gas services are located along local roads near the interchange but are unlikely to be affected by the proposal. Telstra services are located on the southern side of the motorway and a water main runs under the motorway at the northern extent of the proposal.

A thorough utility survey will be conducted and utility authorities will be consulted during concept design and environmental assessment to determine potential impacts and requirements for relocation of utilities where necessary.

Environmental

Roads and Maritime engaged Jacobs Pty Ltd to undertake a preliminary environmental investigation (PEI) to identify and analyse potential environmental constraints and opportunities that may influence the development of the interchange options and third southbound lane.

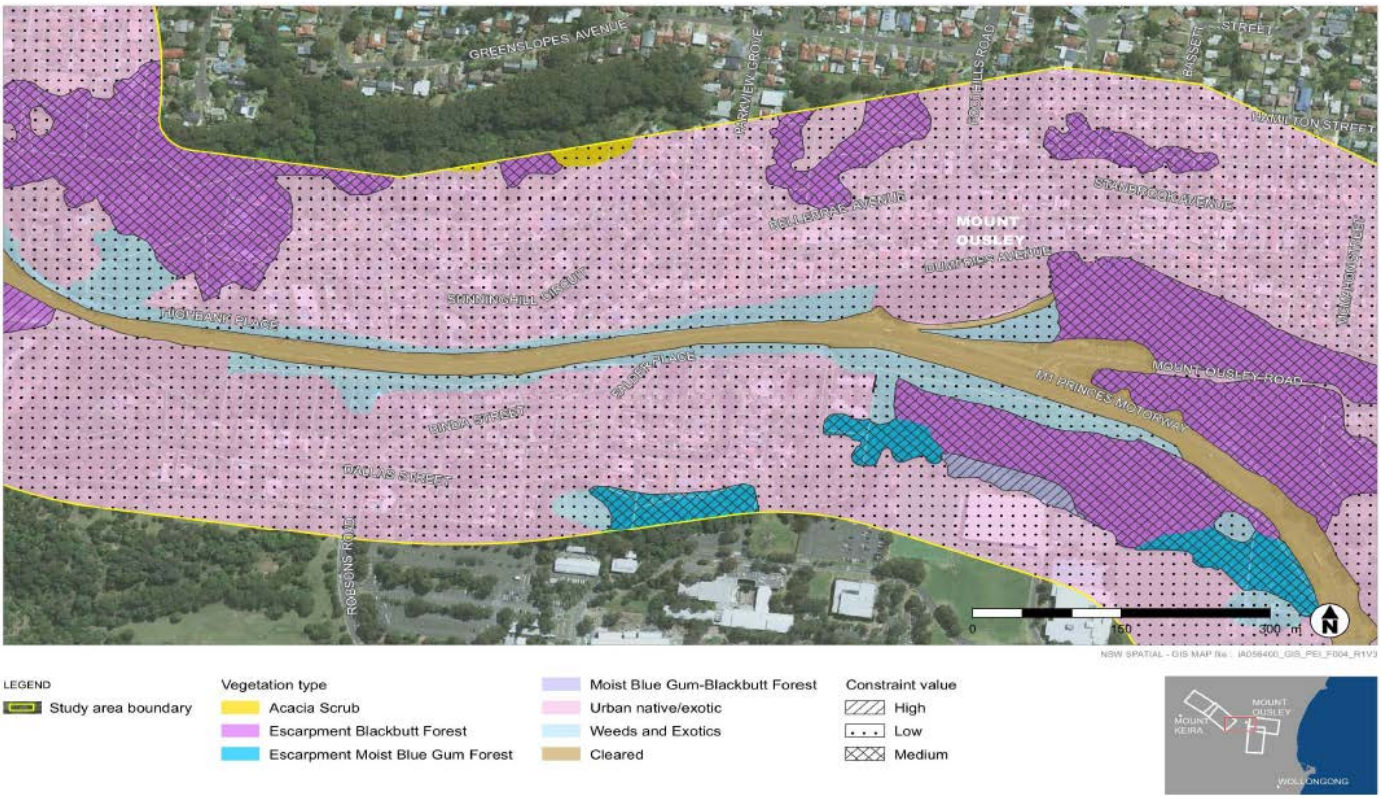
The PEI was based on an identified study area prior to the development of options rather than looking at the potential impacts of each option. The PEI focused on key environmental issues that are considered likely to provide a robust basis for comparing and evaluating each option. These issues are listed below and the key findings summarised in subsequent pages:

- Biodiversity
- Aboriginal heritage
- Non-Aboriginal heritage
- Noise and Vibration
- Urban Design
- Traffic and access
- Land use, property, and socio-economic.

Biodiversity

Biodiversity issues for the proposal would mainly be associated with the removal of native vegetation and habitat from the study area. While no threatened ecological communities, species or populations were recorded in the study area during the field survey, a number of biodiversity constraints were identified.

The overall sensitivity of the biodiversity constraints identified within the study area where the interchange is proposed is indicated in the figure below (as low, medium or highly sensitive).



Key biodiversity constraints identified within the study area include:

- A historic record of two *Environment Protection and Biodiversity Conservation (EPBC) Act* listed flora species, Prickly Bush-pea (*Pultenaea aristata*) and White-flowered Wax Plant (*Cynanchum elegans*)
- Suitable foraging habitat for one EPBC Act listed fauna species, the Grey- headed Flying-fox (*Pteropus poliocephalus*)
- 1.6 hectares of potential habitat for one *Threatened Species Conservation (TSC) Act* listed flora species (Rainforest Cassia; *Senna aclinis*) immediately to the north of the University of Wollongong campus
- 51.99 hectares of native vegetation providing potential habitat for three EPBC Act listed species and 12 TSC Act listed species.

The smaller the footprint of the interchange, the lower the impact the interchange would have on biodiversity. While Option 4 has the second largest footprint of all the interchange options, it is not considered likely to have a significant impact on biodiversity.

Aboriginal Heritage

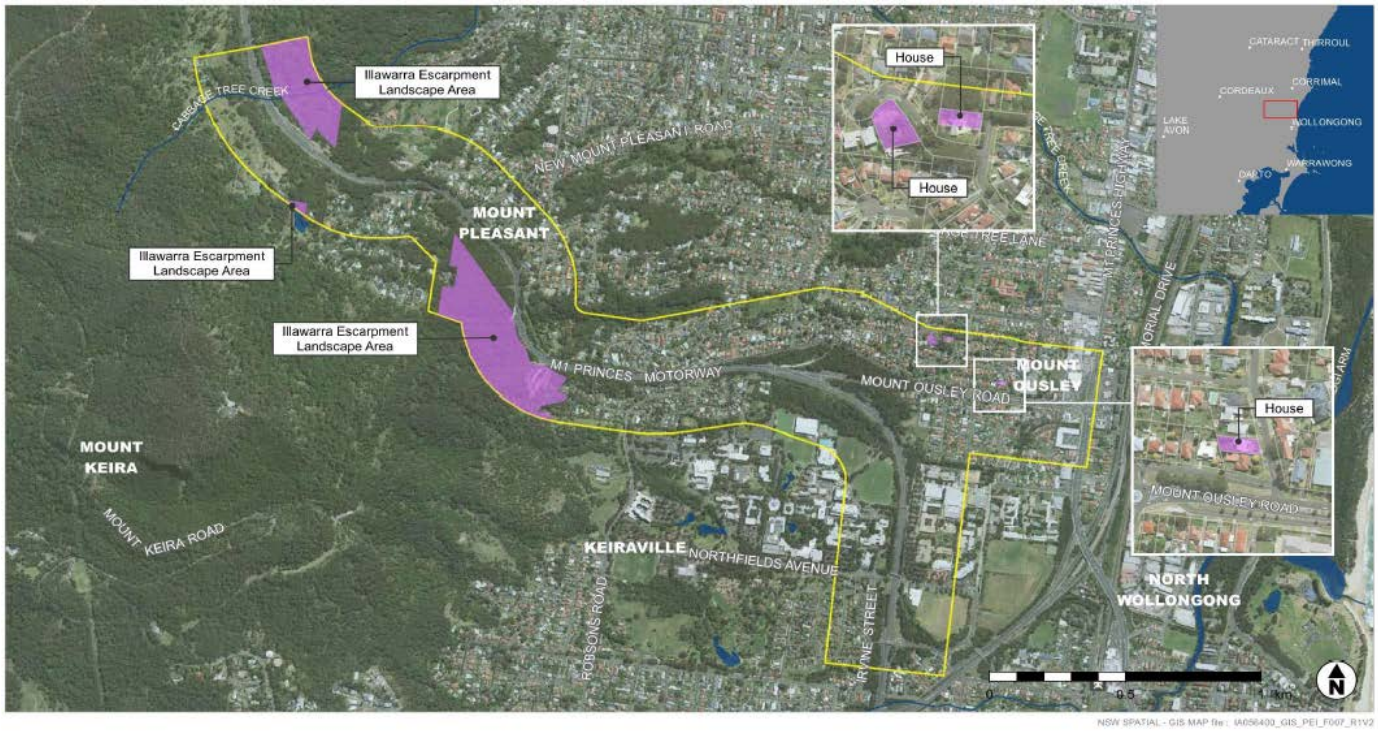
Given the degree of previous ground disturbance that has occurred within the locality, the study area is considered unlikely to contain any items of Aboriginal heritage or Aboriginal archaeological remains. Therefore, the study area is not expected to contain any significant Aboriginal heritage constraints.

A clearance letter was obtained for the study area from the Roads and Maritime Aboriginal cultural heritage advisor stating that no further Aboriginal Heritage investigations are required.

Non-Aboriginal Heritage

The three registered heritage items located in the south-eastern portion of the study area are unlikely to be significant constraints for the proposal, given their location away from the Princes Motorway and Mount Ousley Road. The Illawarra Escarpment Landscape Area, while a

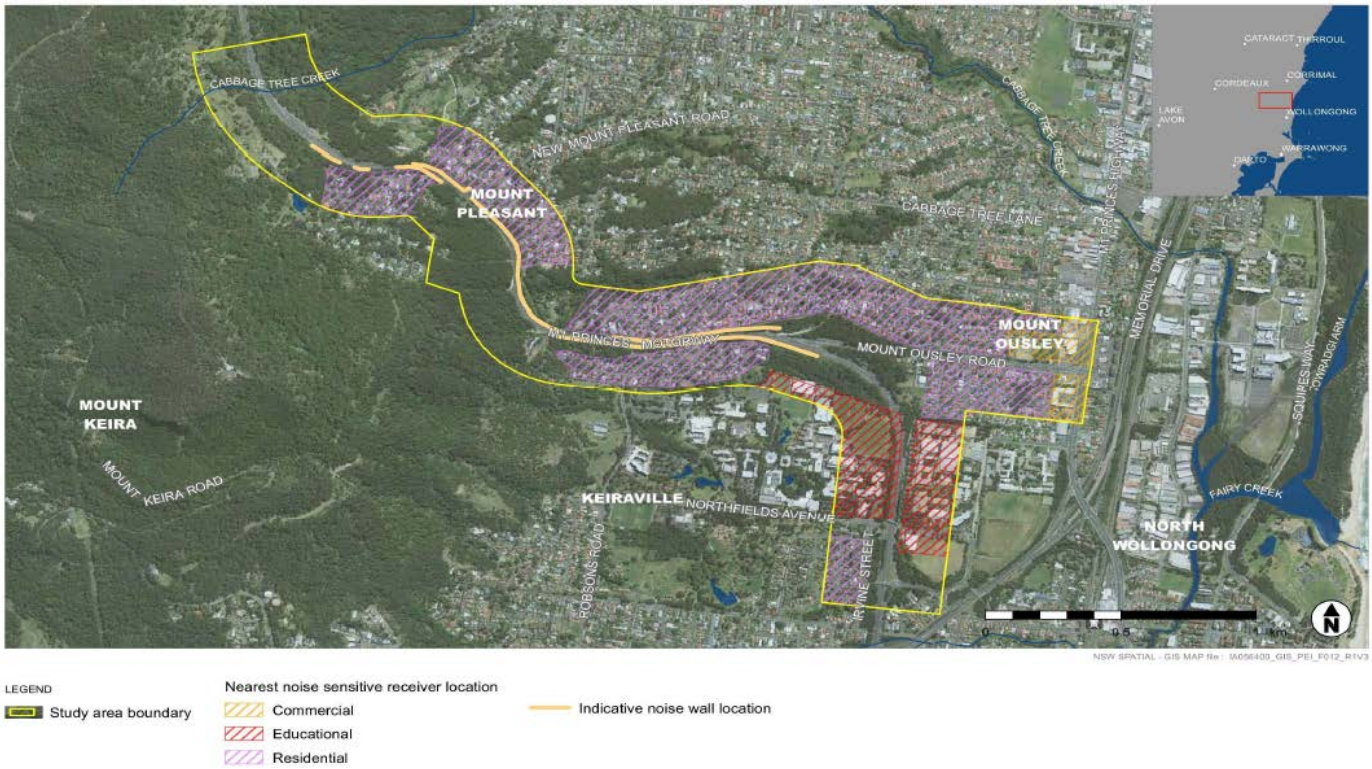
major constraint within the study area for the third southbound lane, would not be impacted by the proposal.



Noise and vibration

Residential and other sensitive receiver locations identified within the study area are shown in the figure below. Residential receiver locations are generally positioned in discrete pockets adjacent to Mount Ousley Road and the Princes Motorway and can be categorised into three suburban areas:

- Mount Pleasant: with the closest receivers located on New Mount Pleasant Road, Paradise Avenue, Dobinson Road, and Brokers Road north of the Princes Motorway; and New Mount Pleasant Road south of the Princes Motorway
- Mount Ousley: with the closest receivers in Northwood Road, Sunninghill Circuit, and Dumfries Avenue north of the Princes Motorway
- Keiraville: with the closest receivers in Binda Street, Dallas Street, and Falder Place south of the Princes Motorway.



LEGEND

- Study area boundary
- Nearest noise sensitive receiver location
  - Commercial
  - Educational
  - Residential
- Indicative noise wall location

South of the Princes Motorway and Mount Ousley Road intersection, there are additional receivers located adjacent to Mount Ousley Road and the Princes Motorway in Gowan Brae Avenue and Irvine Street. These last two locations are separated by the University of Wollongong and Wollongong TAFE, which also bound the road corridor.

There are several commercial properties in the vicinity of the Mount Ousley Road and Princes Highway intersection at the eastern boundary of the study area.

The interchange options are all likely to have relatively similar noise impacts however those with larger footprints are likely to have greater noise impacts as they are positioned closer to sensitive receivers.

A detailed noise study would be undertaken during the environmental assessment of the preferred option in accordance with the road noise policy. Any sensitive receivers found to be impacted by the proposal above defined thresholds would be considered for reasonable and feasible treatments to reduce noise in that location. Noise walls could also be a consideration in the design.

Urban design

Wollongong is a seaside city, located in the Illawarra region wedged between the sea and the Illawarra Escarpment, about 80 kilometres south of Sydney. The Illawarra Escarpment is a mountain range with dramatic sandstone cliffs that strongly contribute to the visual quality and identity of the region. The landform of Mount Keira has an elevation of 464 metres and forms a distinctive landmark highly visible from surrounding areas near the proposed interchange.

Views between Mount Keira and the proposed interchange location

The beauty of Wollongong's natural environment providing pristine beaches and rainforest attracts many visitors to the area. In the immediate vicinity of the interchange, quiet residential neighbourhoods and educational facilities flank both sides of the motorway. Due to the location of sensitive receivers next to the motorway, noise walls are present on both sides of the corridor, limiting the visual interface of surrounding areas with the road. Given the location of the interchange as an important gateway to Wollongong and the university, it is important for the interchange to be carefully designed to improve driver experience and road legibility.

Building on the work completed for the PEI, KI Studio was engaged to undertake an assessment of the strategic options to determine which option would perform the best on balance with respect to landscape character and visual impacts, driver experience, and community issues. A summary is provided in the table below. A low score indicates a better performance and Options 3 and 4 perform the best in this regard.

FACTOR	OPTION 1	OPTION 2	OPTION 3	OPTION 4
Landscape Character Impact	1	3	2	3
Safety and Road Legibility Create a clear legible road network that is safe and easy to use	4	3	2	1
Physical form of the built form elements and their integration in the setting Retain the forest character at the interchange	2	4	1	3
User experience, how the interchange acts as a gateway Create a memorable gateway that contributes to the identity and character of Wollongong	4	3	2	1
Potential views and vistas Retain the amenity of residential areas and educational facilities surrounding the project	2	4	1	3
Community issues Contribute to the urban structure, functioning and permeability of the area	2	4	3	1
Total	15	21	11	12

Traffic, transport and access

Construction

Potential traffic, transport and access constraints during the construction phase of the proposal would mainly be associated with constructability issues regarding the ability to divert general traffic around the worksite without significantly impacting on existing levels of service on the road network.

Given that the Princes Motorway and Mount Ousley Road form a strategically important road freight transport corridor, providing access between Port Kembla, Sydney and the northern Illawarra collieries, the ability to maintain acceptable traffic flow on the Princes Motorway during construction would be an important consideration during the design development and environmental assessment phases of the proposal.

Options 1 and 2 have distinctly different construction traffic impacts than Options 3 and 4.

- Options 1 and 2 would involve construction of a ramp from the right lane of the motorway meaning that traffic would need to be diverted around the work site with difficulty for access into and out of the work site for construction vehicles. Options 1 and 2 also have complex bridge structures over the motorway in more than one location which would require a number of closures on the motorway
- Options 3 and 4 would be largely constructed offline with the exception of the end points where the interchange would join back into the Princes Motorway and Mount Ousley Road meaning that traffic could continue operating on the existing motorway. Options 3 and 4 have simple bridge structures which could be achieved in a single closure.

Land use, property and socio economic

The key land use, property and socio-economic constraints for the study area primarily relate to property acquisition and property adjustments, which could occur in situations where the proposal cannot be contained within the existing road corridor.

All interchange options would require property acquisition from the University of Wollongong. While the university is supportive of the proposal, limiting the area required for property acquisition would reduce impacts and the potential costs of acquisition. Option 1 requires the least amount of property acquisition, followed by Options 2, 3 and 4 in that order.

Other potential land use, property and socio-economic issues that would need to be considered during the design development and environmental assessment phases of the proposal include:

- Temporary disruptions to utilities during construction and the effects that such disruptions would have on residents, local businesses and the community
- Temporary disruptions to access and connectivity within and through the study area during construction and the effects that such disruptions would have on the accessibility of private property, local businesses, social infrastructure (e.g. University of Wollongong and other educational facilities) and the broader Illawarra region
- Temporary disruptions to the local tourism industry and the overall economic efficiency of the Illawarra region due to potential construction traffic impacts on the Princes Motorway and Mount Ousley Road, which could affect accessibility into the region for tourists, freight and commuters
- Adverse effects on existing local amenity and community values of the study area due to construction noise, dust and changes in the study area's landscape character and visual amenity.

Notwithstanding the above constraints, the proposal also has the potential for both local and wider regional benefits in the medium to longer-term through reduced traffic congestion, improved access and connectivity, and improved safety for motorists.

Constructability

A constructability review was undertaken in September 2015 to assess the four interchange design options and the future third southbound lane which is common to all options. The review included key Roads and Maritime staff, cost estimating contractors MI Engineers, and a constructability contractor from Geoff Burrett & Associates.

Major project constraints and factors influencing constructability

The following major constraints and factors were identified by the participants as affecting constructability:

- Steep terrain and limited work space with clearance to traffic, noise walls and buildings
- High volume of traffic including high proportion of heavy vehicles presenting a major safety risk for construction workers
- Options 1 and 2 which require construction of ramps in the middle of the motorway would be difficult to access and provide a safe workspace for workers. Given the limited workspace in the middle of the motorway, separating workers on foot from plant would also be difficult.
- All options require construction on both sides of the motorway meaning haul routes would be required on major public roads including Mount Ousley Road, Princes Highway, Memorial Drive, and the Princes Motorway.
- Bridge works over the motorway would need to be undertaken during closures which currently occur once every three months. Options 1 and 2 have longer and more complex bridge structures which are unlikely to be completed during one closure compared to Options 3 and 4 which have simple bridge structures which are likely to be completed in a single closure.

The overall outcome of the constructability review was that detailed constructability (currently underway) and geotechnical investigations are required for both the proposed interchange and future third southbound lane.

With respect to the interchange designs, Options 3 and 4 were considered superior to Options 1 and 2 from a constructability, traffic management and work health and safety (WHS) perspective. Options 3 and 4 can largely be constructed offline and have a straight single span Super T bridge over the motorway. Options 1 and 2 have long complex bridges with ramps in the middle of the motorway making access and traffic management for construction plant difficult resulting in greater WHS risks.

Risks

A six-step risk management process has been adopted from the Roads and Maritime guidelines for risk management.

The six-step process involves:

1. Establishing the context of the risk
2. Identifying generic risks
3. Identifying actual risks
4. Analysing each risk
5. Evaluating each risk
6. Deciding an appropriate risk treatment strategy.

A risk register was developed at a strategic risk workshop held in August 2015. This workshop involved a range of internal stakeholders and a select group of external stakeholders, including representatives from Wollongong City Council and the University of Wollongong. The workshop focused on project specific risks associated with at least one of the four current options being investigated.

A total of 118 risks were identified across the four options presented. The majority of risks were considered to apply to all options, with nine risks specific to one or more options but not all. As part of the risk workshop, participants proposed mitigation measures for the risks and then assessed the residual risk (the level of risk that would remain following successful implementation of the mitigation).

Key risks identified for the options included constructability, work health and safety (WHS), and traffic management risks during construction. Options 1 and 2 both involve construction of ramps in the middle of the motorway which presents major risks for traffic management (work plant entering and exiting the construction site) and WHS in tight workspaces for manoeuvring within the site and separation of workers from construction vehicles. Options 3 and 4 have greatly reduced risks in this area as they can be largely constructed offline other than tie-ins to the existing roads.

Other risks included driver confusion in Options 1 and 2 leading to potential crashes based on an unconventional layout where exits for light vehicles are in the right lane rather than on the left. This could be mitigated through advanced directional signage however it was considered that the more conventional layout of Options 3 and 4 with exits on the left would create less driver confusion and have reduced risks for introducing new crashes.

Another risk was raised with the design of Options 3 and 4 which include a truck bypass. All trucks would have to merge back onto the Princes Motorway after Mount Ousley Road and before University Avenue over a distance of 490 metres. To address these concerns, a weaving analysis was undertaken in accordance with the Highway Capacity Manual as described above on page 20 (see Road Safety). The weaving analysis showed that the weave movement would operate with sufficient capacity beyond the modelling analysis period to 2041.

Economic analysis

An economic appraisal has been completed based on the four strategic designs options. The economic appraisal has followed the Principles and Guidelines of Economic Appraisal of Transport Investment and Initiatives and the National Guidelines for Transport System Management in Australia.

Key benefits defined during initial planning for the Princes Motorway and Mount Ousley Road interchange project include:

- Improved level of service (travel efficiency) for this section of the motorway, especially around the connection with Mount Ousley Road
- Reduction in crashes, especially the most injurious (right angle, adjacent approach) which are associated with the at-grade right turn from Mount Ousley Road onto the motorway
- Improved travel times for all vehicles, including improvements for heavy vehicles
- Reduced vehicle operating costs
- Improved access to the Wollongong CBD and the University of Wollongong.

The majority of benefits come from travel time savings and vehicle operating costs, which have been found on major road upgrades, especially where capacity improvements are being provided to typically account for 80 per cent or more of the project benefit. The contribution of travel time savings across the four options is in the range of 85 to 90 per cent.

The cost of Options 1, 3 and 4 are fairly similar with Option 3 being the lowest cost and Options 1 and 4 being five per cent more than Option 3. Option 2 due to its large and complex bridge structures is the highest cost option costing two thirds more than Option 3.

The options all address the safety and efficiency issues similarly with the exception of Option 4 which has the added benefit of providing a new exit from the university. This new exit would reduce congestion within the university and surrounding local road network particularly in the afternoon peak.

While all options were assessed to be economically worthwhile, Option 4 with the greatest benefits and only slightly higher costs was assessed to be the preferred option from an economic perspective with benefits outweighing costs by 2.8 to 1.

Value Management Workshop

An options selection Value Management (VM) workshop was held in Wollongong in December 2015 bringing together Roads and Maritime staff from a range of backgrounds, Transport for NSW, Wollongong City Council, and the University of Wollongong. The purpose of the workshop was to assess each option against a range of agreed functional, socioeconomic, and environmental criteria in order to select a preferred option for further development. The findings of the VM workshop are summarised below.

The options were judged on a qualitative basis of how well each option met each category's assessment criteria relatively on a scale of 4 to 1. The option which best addressed or met the specific criteria was allocated the score of 4. Then the group assessed the relative performance of the other option under that criteria. The score 3 meant the performance was a little bit worse, 2 was a bit worse still and 1 was a fair bit worse.

Once the qualitative evaluation was completed, the evaluation was scored using the weightings of the criteria and establishing a ranking for each option within that category.

The detailed scoring of each option against each criteria is presented in Appendix A and summarised below.

Summary of option evaluation

Option	***Functional (Rank and score)***	***Socio Economic & Environmental (Rank and score)***	***Cost***	***BCR***
Option 1	**3** 236	**1** 364	1.05	2.1
Option 2	**4** 186	**4** 186	1.67	1.4
Option 3	**2** 341	**2** 300	1.00	2.0
Option 4	**1** 400	**3** 242	1.05	2.8

It was agreed by the participants of the VM workshop that due to the relatively limited environmental impacts of the options, that functional criteria were considered to be of greater importance. Option 4 was therefore unanimously recommended by all groups at the VM workshop as the favoured option for further development because:

- Traffic safety is considered better than Options 1 and 2 with improved legibility less likely to cause driver confusion
- Worker safety is markedly improved compared to Options 1 and 2 during construction, operation and maintenance
- It represents best value for money based on Benefit Cost Ratio (BCR) with the exit provided from the university
- Offers the best functionality and accessibility
- Manages heavy vehicles around and through the intersection
- The exit ramps are controlled by roundabouts providing a clear distinction between the motorway and lower order road environments
- Better access to the commuter car park
- Reduced maintenance risks

This is subject to:

- Confirming the weave movement south of the heavy vehicle bypass on the way to the University Avenue interchange can operate efficiently
- Consultation around the commuter car park relocation
- Availability of funding relative to Option 3 as the additional benefits of Option 4 are to the university and local road network which are not the responsibility of Roads and Maritime.
- Confirming satisfactory construction staging

Conclusion and next steps

Option 4 has been selected as the preferred option as it would provide a value for money solution with greater traffic benefits than all other options. Option 4 was selected by all who attended the Value Management Workshop held in December 2015, which included key external stakeholders, as the option to progress for futher development.

Roads and Maritime is now seeking feedback from the community on the design. This feedback would be considered during the concept design and environmental assessment. Key aspects that Roads and Maritime are seeking feedback on are potential locations for a new commuter car park and pedestrian and cyclist facilities across the motorway. Refer to the Roads and Maritime website at www.rms.nsw.gov.au/MountOusleyInterchange for more information and to provide your feedback.

Following feedback from the community, the concept design and environmental assessment for the preferred option will be completed and is expected to be displayed for further community comment in 2017.

Appendix A – Value Management Workshop Assessment

Assessment criteria weighting

Relative weighting of assessment criteria was completed by the whole group using a paired comparison approach. This process involved assessing the relative importance of the respective criteria by comparing each criterion to every other criterion to determine which is collectively viewed as being the most important.

If the group was unable to differentiate between the two criterions under consideration they are given equal weight.

The group's workings and their weightings of the assessment criteria for each category are shown below:

Functional criteria

No.	Criteria	Raw Score	Relative Weight
A.	Improve road safety	6	27
B	Improve reliability of travel times and efficiency for all vehicles on the state network	4	18
C.	Enhance cycle/pedestrian links	2	9
D.	Minimise health and safety risk (during construction, operation and maintenance)	6	27
E.	Constructability	1	5
F.	Improve road and network legibility	3	14
G	Ability and flexibility to stage delivery to match funding	0	0
	Total	**22**	**100**

Scoring matrix

The workings for the relative assessment are shown below.

	B	C	D	E	F	G
A	A	A	A/D	A	A	A
	B	B	D	B	B	B
		C	D	C	F	C
			D	D	D	D
				E	F	E
					F	F

Comments

The participants agreed that the criterion weighting was a fair assessment of relative importance. The higher weighting allocated to "improve road safety" and **"**minimise health and safety risk during construction, operation and maintenance" was acknowledged as fair and appropriate.

While the "Ability and flexibility to stage delivery to match funding" was considered important, it was considered by the group to be less important than the other criteria and accordingly received a score of zero. The group still assessed each option against this criterion.

Socio economic and environmental criteria

No.	Criteria	Raw Score	Relative Weight
A.	Minimise impacts to visual landscape and character.	5	29
B	Improve the driver experience	2	12
C.	Enable easy access to relocated commuter car park to/from the M1 Princes Motorway	1	6
D.	Minimise impacts (noise, vibration, acquisition) on adjacent land owners	5	29
E	Minimise local biodiversity impacts	3	18
F	Minimise overall project environmental impacts eg spoil management, soil erosion, runoff management	1	6
	Total	17	100

Scoring matrix

The workings for the relative assessment are shown below.

	B	C	D	E	F
A	A	A	A/D	A/E	A
	B	B	D	E	B
		C	D	E	C

D	D	D
	E	F

Comments

The participants reflecting on the weighting expressed some surprise that weight afforded to "improve the driver experience" on first glance appeared higher than what might have been expected and that minimise overall environmental impacts appeared lower than what might have been expected. The group did however acknowledge that environmental considerations were in part accounted for in the minimise local biodiversity impacts.

On final review the group agreed that the assessment was fair and that the relative weights should be used in the option evaluation process.

Summary

A summary of the weightings of the assessment criteria within the three categories as determined by the group for option assessment appears below. It should be noted that while enhance cycle/pedestrian links scored 0, this does not mean that it was not important but that it was considered by the workshop group to be of lower importance when compared with the other functional criteria.

Assessment criteria			
Functional		**Socio economic and Environmental**	
Criteria	**Wt**	**Criteria**	**Wt**
Improve road safety	27	Minimise impacts to visual landscape and character.	29
Improve reliability of travel times and efficiency for all vehicles on the state network	18	Improve the driver experience	12
Enhance cycle/pedestrian links	9	Enable easy access to relocated commuter car park to/from the M1 Princes Motorway	6
Minimise health and safety risk (during construction, operation and maintenance)	27	Minimise impacts (noise, vibration, acquisition) on adjacent land owners	29
Constructability	5	Minimise local biodiversity impacts	18
Improve road and network legibility	14	Minimise overall project environmental impacts eg spoil management, soil erosion, runoff management	6
Ability/flexibility to stage delivery to match funding	0		
Totals	**100**		**100**

Option evaluation

The options were judged on a qualitative basis of how well each option met each category's assessment criteria relatively on a scale of 4 to 1. The option which best addressed or met the

specific criteria was allocated the score of 4. Then the group assessed the relative performance of the other option under that criterion. The score 3 meant the performance was a little bit worse, 2 was a bit worse still and 1 was a fair amount worse.

Once the qualitative evaluation was completed, the evaluation was scored using the weightings of the criteria and establishing a ranking for each option within that category.

The group's assessment for the crossing options follows.

Options	***Wt***	***Option 1***		***Option 2***		***Option 3***		***Option 4***	
		Rate	∑	*Rate*	∑	*Rate*	∑	*Rate*	∑
Improve road safety	27	2	54	2	54	3	81	4	108
Improve reliability of travel times and efficiency for all vehicles on the state network	18	3	54	3	54	3	54	4	72
Enhance cycle/pedestrian links	9	4	36	2	18	4	36	4	36
Minimise health and safety risk (during construction, operation and maintenance	27	2	54	1	27	4	108	4	108
Constructability	5	2	10	1	5	4	20	4	20
Improve road and network legibility	14	2	28	2	28	3	42	4	56
Ability/flexibility to stage delivery to match funding	0	3	0	3	0	3	0	3	0
Total Weighted Score			**236**		**186**		**341**		**400**

Comments:

Improve road safety: Options 3 and 4 were considered to perform better than Options 1 and 2 as they have a more conventional exit ramp layout with exits from the left as opposed to the right. Option 4 was considered to perform better than Option 3 as the dual roundabouts would slow vehicles down and provide a clear distinction between the motorway and lower order roads. The heavy vehicle bypass in Options 3 and 4 also provides greater separation between heavy and light vehicles than Options 1 and 2.

Improve reliability of travel times and efficiency for all vehicles on the state road network: All options would provide a substantial and similar level of traffic improvement with the exception of Option 4 which provides for a new exit from the university with has additional benefits.

Enhance cycle/pedestrian links: All options provide for the same pedestrian and cycle links with the exception of Option 2. Option 2 provides a less direct connection to the university for suburbs to the north and east due to the interchange geometry requiring pedestrians and cyclists to travel further up Dumfries Avenue to access the facility.

Minimise health and safety risk (during construction, operation and maintenance: Options 3 and 4 score the highest as the majority of construction is offline and they have simple bridge

structures over the motorway. Options 1 and 2 score lower as they require construction in the middle of the motorway. Option 2 scores the lowest due to the length and complexity of the bridge structures.

Constructability: Again Options 3 and 4 have simple bridge structures, while Options 1 and 2 have longer skewed bridges.

Improve road and network legibility: Options 3 and 4 were considered to perform better than Options 1 and 2 as they have a more conventional exit ramp layout with exits from the left as opposed to the right. Option 4 was considered to perform better than Option 3 as the dual roundabouts would slow vehicles down and provide a clear distinction between the motorway and lower order roads.

Evaluation of options against socio economic and environmental assessment

Options	***Wt***	***Option 1***		***Option 2***		***Option 3***		***Option 4***	
		Rate	∑	*Rate*	∑	*Rate*	∑	*Rate*	∑
Minimise impacts to visual landscape and character.	29	4	116	1	29	3	87	2	58
Improve the driver experience	12	2	24	2	24	4	48	4	48
Enable easy access to relocated commuter car park to/from the M1 Princes Motorway	6	2	12	2	12	2	12	4	24
Minimise impacts (noise, vibration, acquisition) on adjacent land owners	29	4	116	1	29	3	87	2	58
Minimise local biodiversity impacts	18	4	72	1	18	3	54	2	36
Minimise overall project environmental impacts eg spoil management,	6	4	24	2	12	2	12	3	18
Total Weighted Score			**364**		**124**		**300**		**242**

Comments

Minimise impacts to visual landscape and character: The order of rank is based on the footprint of the option, Option 2 having the largest footprint followed by Options 4, then 3, and Option 1 having the smallest footprint.

Improve the driver experience: Option 1 performs the worst as the on and off ramps in the centre of the motorway create a confined motorway setting with limited visual quality. Option 2 performs slightly better as the staggered on and off ramps would improve the confined character of the interchange from the motorway. Forest fragmentation however detracts from the visual setting. Option 3 has a relatively open character for interchange users. Limited forest fragmentation allows the forest character to be expressed. Option 4 has the most open character due to generous verge between the northbound on-load ramp and the motorway. The more prominent bridge structure in Option 4 also assists this option to enhance its presence as a gateway feature.

Enable easy access to relocated commuter car park to/from the M1 Princes Motorway: Option 4 provides for the opportunity to relocate the commuter car park as a fourth leg of the interchange roundabout providing full access to the motorway and local road network. All other options however would require relocation with access to another road resulting in longer and more circuitous trips to access the motorway.

Minimise impacts (noise, vibration, acquisition) on adjacent land owners: The scoring against this criterion was largely to do with footprint and therefore land acquisition areas and proximity to sensitive receivers.

Minimise local biodiversity impacts: Again this criterion was largely based on footprint and therefore on the amount of clearing required to achieve the interchange design.

Minimise overall project environmental impacts eg spoil management: Option 1 has the least amount of cut and fill and therefore spoil and scored the highest. Option 4 has a large amount of cut, equal to option 3, however requires more fill than Option 3 and therefore will lead to reduced spoil. Option 2 requires cut however this would all likely be spoiled as all areas of fill require imported material and accordingly scores the worst for this criterion.

Summary of option evaluation

A summary of the options rankings against the various assessment categories together with the ranking of the capital cost estimates appears below.

Comparative information was also provided on the order of capital costs as well as the benefit cost ratios for the options.

The order of capital costs for each option is relative to the lowest cost option i.e. Option 3.

Option	***Functional (Rank and score)***	***Socio Economic & Environmental (Rank and score)***	***Cost***	***BCR***
Option 1	**3** 236	**1** 364	1.05	2.1
Option 2	**4** 186	**4** 186	1.67	1.4
Option 3	**2** 341	**2** 300	1.00	2.0
Option 4	**1** 400	**3** 242	1.05	2.8

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