GOOGONG NH345

OLD COOMA ROAD & BUNYIP DRIVE INTERSECTION FORM REVIEW

3RD SEPTEMBER 2021

1. INTERSECTION FORMS CONSIDERED

For the intersection of Old Cooma Road/Bunyip Drive the following intersection layouts were assessed:

1. Roundabout
2. Roundabout with a bypass lane
3. Priority give-way
4. Signalised Intersection
5. Signalised Intersection with a bypass lane

For the purposes of this analysis Urban Design features have not been considered. It has also been assumed that pedestrian crossings from Googong to the western verge of Old Cooma Road is not warranted.

This memo should be read in conjunction with the Working Paper 1: TRACKS Model Updates Report, which supplies road volumes for each road in Googong and Working Paper 2: Bunyip Drive – Cross Section Review.

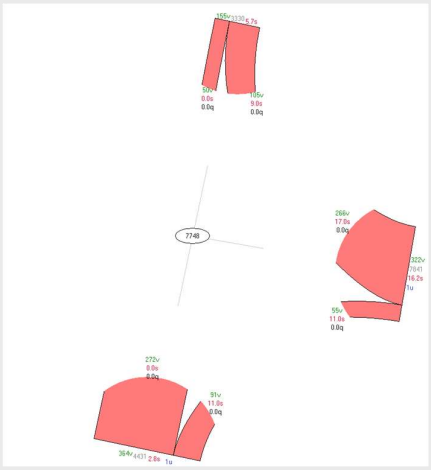
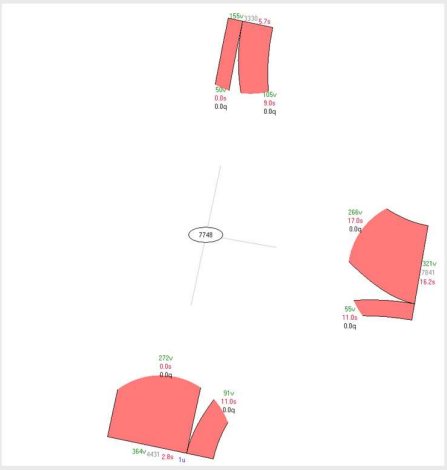
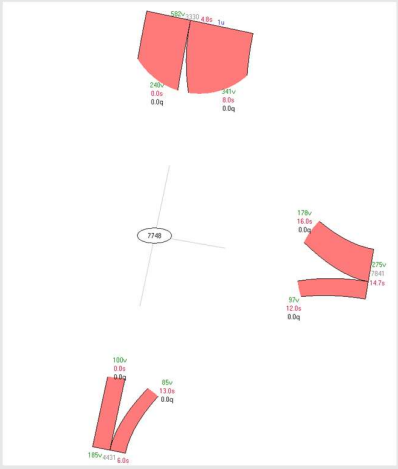
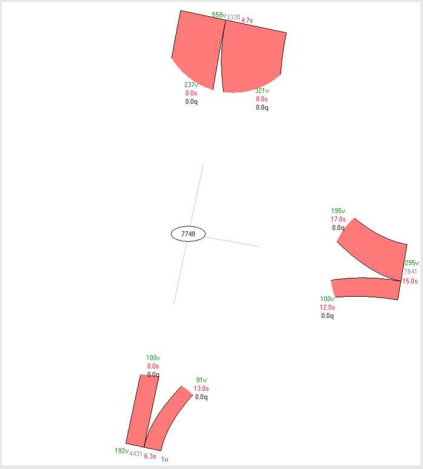
2. TRAFFIC MODELLING ASSUMPTIONS

2.1 Intersection Traffic Forecasts

Intersection volumes were extracted from the TRACKS model discussed in Working Paper 1: TRACKS Model Updates Report. As there is the potential for a planning proposal that would increase the traffic on these intersections, the planning proposal volumes are used as the primary planning figures rather than the yield at the completion of the subdivision development application for Neighbourhood 3, 4 & 5. This provides certainty to Council that the intersections are appropriately future-proofed, and no further works would be required in that potential future application.

Traffic volumes are provided in the format supplied by TRACKS in Table 1. The volumes are generally in the order of 100 to 600 vehicles per intersection approach.

Table 1: 2031 peak hour traffic forecasts at the intersection of Bunyip Drive/Old Cooma Road

Peak	Subdivision Application Scenario	Planning Proposal Scenario
AM		
PM		

2.2 Intersection Performance

Traffic modelling was undertaken using SIDRA 9.0 for the intersection of Old Cooma Road / Bunyip Drive. Operational performance is typically measured through an assessment of the throughput of vehicles across a traffic network, with average delay per vehicle used to assess the performance of an individual intersection. This is consistent with Roads and Maritime Service best practice and is the industry standard for the assessment of intersection performance. The average delay per vehicle measure is linked to a Level of Service (LoS) index which characterises the intersection's operational performance. Table 2 provides a summary of the LoS performance bands.

Table 2: Level of Service Index

Level of Service	Average Delay per Vehicles (sec/h)	Traffic Signals / Roundabout	Give Way / Stop Signs
A	Less than 14.5	Good operation	Good operation
B	14.5 to 28.4	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	28.5 to 42.4	Satisfactory	Satisfactory, but incident study required
D	42.5 to 56.4	Operating near capacity	Near capacity and incident study required
E	56.5 to 70.4	At capacity, at signals incidents will cause excessive delays. Roundabouts require other control method.	At capacity, requires other control method
F	70.5 or greater		

Source: Guide to Traffic Generating Developments; Roads and Maritime Services; 2002

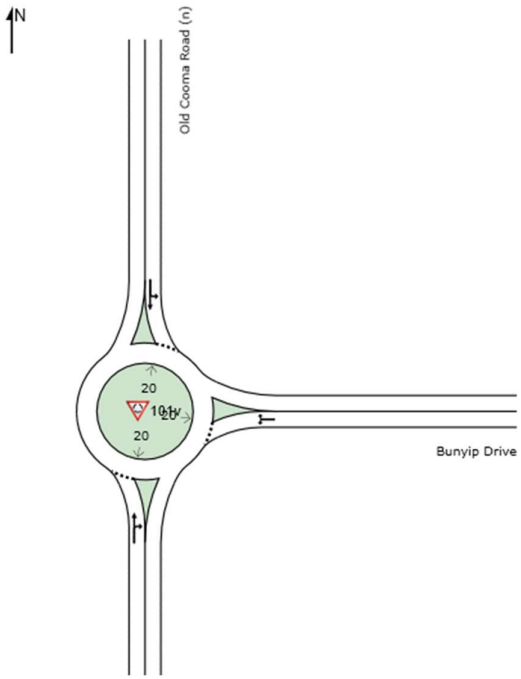
3. INTERSECTION ASSESSMENT

3.1 Roundabout

3.1.1 Traffic

A single lane roundabout was modelled as shown in Figure 1. Based on the full development of Googong's forecast traffic, as shown in Table 1, the intersection will perform at Level of Service A in the AM peak and Level of Service A in the PM peak with acceptable delays.

Figure 1: Old Cooma Road/Bunyip Drive – Roundabout



3.1.2 Geometry

A preliminary intersection layout demonstrating the proposed geometry has been depicted in sketch CX031 provided attached to this memo.

Advantages:

- Roundabouts are a beneficial intersection treatment when a high proportion of right-turning traffic is proposed,
- Promotes vehicles to reduce their speed on approach,
- Fewer conflict points and relatively low angle of conflict between entering and circulating traffic therefore reducing the number and severity of crashes; and,
- Trees and other high landscaping features may be positioned in the inner area of the central island, provided it is large enough to ensure that sight lines are not impeded, and clear zone requirements are met.

Disadvantages:

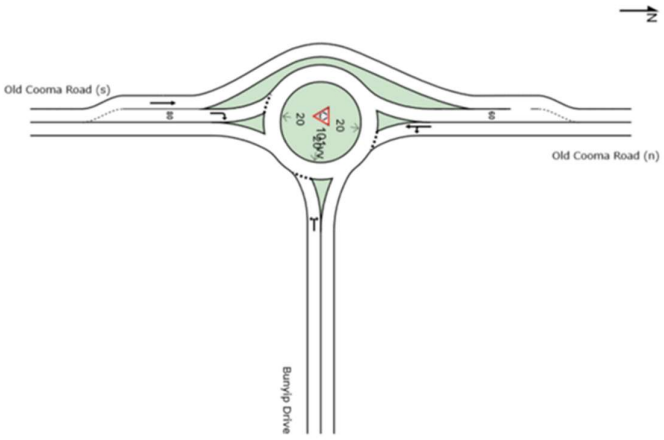
- Roundabout is offset to avoid impacting the existing western road reserve boundary. This offset positions a larger proportion of the intersection under the proposed 132kV overhead power, increasing the length of road the 132kV poles are spanning,
- The roundabout offset does not provide a desirable line of travel for southbound traffic. The offset of the roundabout creates a low-speed exit for southbound traffic and accelerating on exit will not be easily achieved.
- Speed reduction treatments are required for 80km/hr posted roundabouts to alert drivers to a change in environment and encourage a more gradual reduction in vehicle speeds; and,
- Significant increase in land take required to accommodate intersection form.

3.2 Roundabout with Bypass Lane

3.2.1 Traffic

A single lane roundabout with a bypass lane was modelled as shown in Figure 2. Based on the full development of Googong's forecast traffic, as shown in Table 1, the intersection will perform at Level of Service A in the AM peak and Level of Service A in the PM peak with acceptable delays.

Figure 2: Old Cooma Road/Bunyip – Roundabout with Bypass Lane



3.2.2 Geometry

A preliminary intersection layout demonstrating the proposed geometry has been depicted in sketch CX032 provided attached to this memo.

Advantages (In Addition to Section 3.1.2)

- Enables northbound right turning traffic into Googong to decelerate clear of through traffic.

Disadvantages (In Addition to Section 3.1.2)

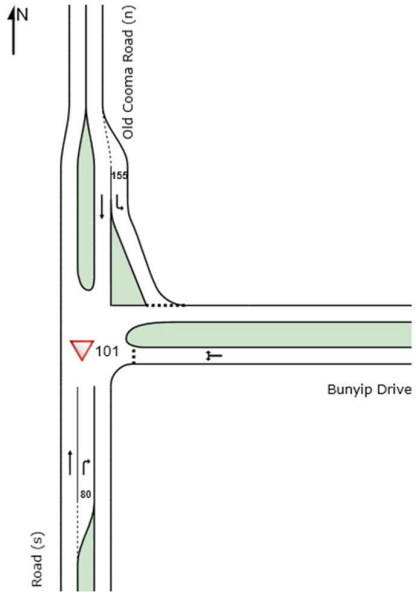
- Land acquisition required along the western boundary of Old Cooma Road to adequately accommodate the bypass lane,
- Promotes high speed environment when northbound traffic bypassing the intersection,
- Adequate distance for acceleration lane to merge with the bypass lane cannot be accommodated without impacting the existing intersection of Fernleigh Drive/Old Cooma Road (see Section 6 below).

3.3 Priority Intersection

3.3.1 Traffic

A priority intersection was modelled with the same layout that was assessed at Structure Plan Phase in the *Neighbourhood 3, 4 & 5 Traffic Report* prepared by Calibre as depicted in Figure 3. Based on the full development of Googong's forecast traffic, as shown in Table 1, the intersection is forecast to perform at Level of Service A with minimal delays. A higher degree of saturation and delays is expected in the AM peak compared to the PM Peak with higher traffic volumes forecast to turn right from Bunyip Drive that need to give way to traffic on Old Cooma Road.

Figure 3: Old Cooma Road/Bunyip Drive – Priority



3.3.2 Geometry

A preliminary intersection layout demonstrating the proposed geometry has been depicted on sketch CX019 provided attached to this memo.

Advantages – Give Way Arrangement:

- Location of intersection is straight and generally flat which is conducive to a priority controlled T-intersection form,
- Intersection layout can be compact and minimises disturbance to adjacent land,
- There is adequate sight distance available and a good perception of the treatment,
- Traffic travelling along Old Cooma Road will not be impacted by vehicles on Bunyip Drive or waiting times associated with signals or roundabouts; and,
- Flexibility of staging the intersection if signals are warranted in the future.

Disadvantages – Give Way Arrangement:

- Motorists are required to determine an appropriate gap acceptance when completing a right turn movement; and,
- Public Transport are not provided with a priority movement.

Sketch CX018 has also been prepared to demonstrate a priority intersection seagull arrangement and has been attached to this memo. A seagull turn treatment provides a channelised protection for right turn traffic when entering a through traffic stream at a T-junction.

Advantages – Seagull Intersection:

- An operational advantage in right turners from the Bunyip Dr being able to accept a gap at the first carriageway and merge with Old Cooma Road traffic at the second carriageway,
- Appropriate at locations where right turns from the terminating leg experience delays due to lack of gaps,
- Provides storage for right turn movements,
- Enables turning traffic to accelerate clear of through traffic; and,
- Median and separation protects and guides through vehicles, remaining clear of stationary Old Cooma Road right turn traffic

Disadvantages – Seagull Intersection:

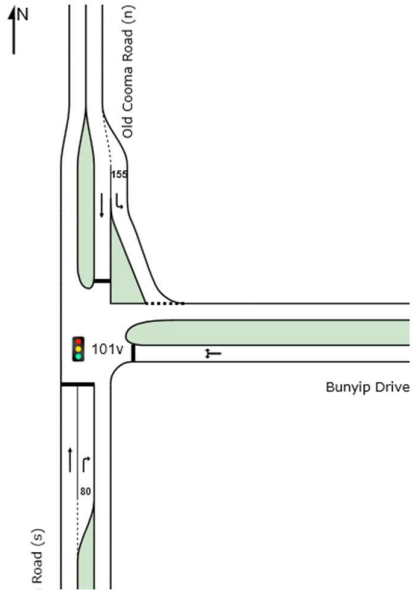
- Requires additional pavement width on major road to accommodate turning movements and merge taper for through movement,
- Adequate distance for acceleration lane cannot be accommodated without impacting the existing intersection of Fernleigh Drive/Old Cooma Road,
- If the acceleration lane is reduced too significantly and heavy vehicles merge at a much slower speed then the through traffic, it can be difficult for drivers on the through road to determine whether to brake or accelerate at the merge; and,
- Austroads cautions the use of a seagull arrangement particularly in high speed areas.

3.4 Signalised Intersection

3.4.1 Traffic

A set of traffic signals was modelled with the layout shown in Figure 4. Based on the full development of Googong's forecast traffic, as shown in Table 1, the intersection is forecast to perform at Level of Service B with acceptable delays. The delays to be experienced by drivers will increase if this intersection is signalised when compared to priority-controlled or a roundabout.

Figure 4: Old Cooma Road/Bunyip Drive – Traffic Signals



3.4.2 Geometry

A preliminary intersection layout demonstrating the proposed geometry has been depicted on sketch CX017 provided attached to this memo

Advantages:

- Reduced number of conflict points
- Can readily accommodate priority measures for public transport
- Eliminates the gap acceptance decision requirement for right turn movements

Disadvantages*:*

- Northbound motorists may be surprised by the location of a signalised intersection as there is no indication of an urbanised area prior to the approach.
- Austroads notes that signalised intersections are generally not desirable from a safety perspective in high-speed environments
- A significant benefit for introducing traffic signals would need to be demonstrated that cannot be achieved by other means
- Driver discipline is an essential feature of traffic signals and when not warranted can lead to noncompliance by drivers

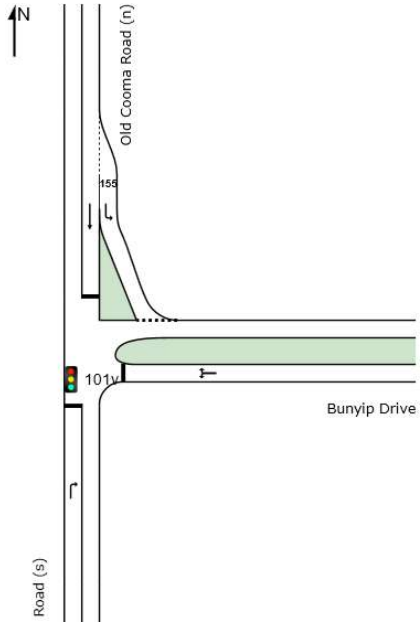
- There is no overwhelming benefit to pedestrians and cyclists by introducing traffic signals as crossing demands is foreseen as low

3.5 Signalised Intersection – Bypass lane

3.5.1 Traffic

A set of traffic signals was modelled with the layout shown in Figure 5. It is noted that the northbound through traffic lane and the associated traffic volumes have not been modelled as they are not required to stop through the bypass lane. Based on the full development of Googong's forecast traffic, as shown in Table 1, the intersection is forecast to perform at Level of Service B with acceptable delays. The overall intersection delays have slightly reduced in the AM peak as the northbound traffic does not need to stop through the bypass lane.

Figure 5: Old Cooma Road/Bunyip Drive – Traffic Signals with Bypass Lane



3.6 Geometry

A preliminary intersection layout demonstrating the proposed geometry has been depicted on sketch CX017 provided attached to this memo

Advantages (In Addition to Section 3.4.2):

- Median separation protects and guides through vehicles, remaining clear of stationary right turn traffic
- Enables turning traffic to decelerate clear of through traffic

Disadvantages (In Addition to Section 3.4.2):

- Promotes high speed environment when northbound traffic bypassing the intersection
- Requires relocation of Fernleigh Drive and/or Bunyip Drive to achieve required intersection spacing (see Section 6 below)

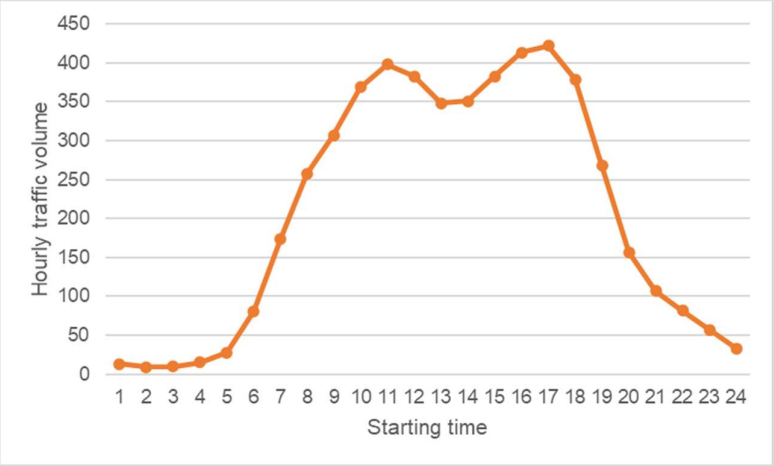
4. TRAFFIC SIGNAL WARRANTS

TfNSW lists general warrants for installation of traffic signals in *Traffic Signal Design – Section 2 Warrants* document (RTA). The document stresses that the list is a guide and that traffic signals may not be the most optimal solution, even if the site satisfies the warrants. Conversely, traffic signals may be installed irrespective of general warrants due to external factors.

It is assumed that the traffic volumes in the horizon year (2031) have considered all approved development within the catchment area that would use the potential new signalised intersection at Old Cooma Road / Bunyip Drive.

It is noted that the warrant criteria must be satisfied for each of four one-hour periods of an average day. Hence, the two one-hour peak traffic forecasts were expanded to an hourly traffic volume of 24 hours based on the typical daily traffic profile of the nearest permanent traffic counter at Monaro Highway (1.94km south of Braidwood Street), as shown in Figure 6, which is not a representative of Googong or Bunyip Dr/Old Cooma Rd. The road network peak occurs between 8am and 11am and 3pm and 6pm. The profile showed that traffic volumes recorded from 9-11am could be between 20 to 30 per cent higher than the typical road network peak at 8-9am. In the afternoon peak, traffic is 10 per cent higher during 3-4 pm when compared to the typical road network peak at 5-6pm.

Figure 6: Daily Traffic Profile of Monaro Highway



Source: Transport for NSW Traffic Volume Viewer Station 6114

The expected approach volumes during the AM and PM peak periods are shown below in. Traffic volumes that are higher than 600 veh/hr in each direction are highlighted in red and minor approaches with traffic volumes of more than 200 are highlighted in green in the table below.

Table 3: Traffic Volumes On Each Approach during 2031 AM and PM Peak Period (six hours)

Peak period	Time	Traffic volumes for all approaches			Total throughput
		N	E	S	
AM	8:00-9:00	59	457	429	945
	9:00-10:00	71	549	516	1,136
	10:00-11:00	76	592	556	1,225
PM	3:00-4:00	600	242	212	1,055
	4:00-5:00	614	247	217	1,078
	5:00-6:00	551	222	195	968

The peak period traffic volumes for all approaches are reviewed against the TfNSW warrant criteria to establish whether signals are required at the intersection of Old Cooma Road / Bunyip Drive. Table 4 presents the findings of the review. Based on the review against the TfNSW warrant criteria, the intersection of Old Cooma Road / Bunyip Drive does not warrant traffic signals based on the 2031 traffic forecasts

Table 4: Warrant Criteria Review Results

Warrant	Criteria	AM	PM	Warrants met?
a) Traffic demand	(i) The major road flow exceeds 600 vehs / h in each direction; and	No	No	No
	(ii) The minor road flow exceeds 200 vehs / h in one direction.	No	**Yes**	
b) Continuous traffic	(i) The major road flow exceeds 900 vehs / h in each direction; and	No	No	No
	(ii) The minor road flow exceeds 100 vehs / h in one direction; and	No	Yes	
	(iii) The speed of traffic on the major road or limited sight distance from the minor road causes undue delay or hazard to the minor road vehicles; and	TBC	TBC	
	(iv) There is no other nearby traffic signal site easily accessible to the minor road vehicles.	No	No	
c) Pedestrian safety	(i) The pedestrian flow crossing the major road exceeds 150 persons / hr; and	Very unlikely^	Very unlikely^	No
	(ii) The major road flow exceeds 600 vehicles / hr in each direction or, where there is a central median of at least 1.2m wide, 1,000 vehicles / hr in each direction.	No	No	
	(i) The pedestrian flow crossing the major road exceeds 150 persons / hr; and	Very unlikely^	Very unlikely^	No

d) Pedestrian safety – high speed road	(ii) The major road flow exceeds 450 vehicles / hr in each direction or, where there is a central median of at least 1.2m wide, 750 vehicles / hr in each direction; and	No	No	
	(iii) The 85th percentile speed on the major road exceeds 75 km / hr.	TBC	TBC	
e) Crashes	(i) The intersection has been the site of an average of three or more reported towaway or casualty traffic accidents per year over a three year period, where the traffic accidents could have been prevented by traffic signals; and	TBC	TBC	No
	(ii) The traffic flows are at least 80% of the appropriate flow warrants.	No	No	

Source: SCT Consulting, 2020

*- The warrant criteria must be satisfied for each of four one-hour periods of an average day.
^- There is no development to the west of Old Cooma Road that generates any pedestrians to cross the major road.
TBC – these parameters couldn't be assessed as speed data is not available

5. OPINION OF PROBABLE COSTS

A preliminary opinion of probable cost has been prepared and summarised in Table 5 for the roundabout, priority controlled giveway intersection, seagull intersection and signalised intersection form. The opinion of probable cost assessment has excluded any items that would make a negligible difference to costs for the purposes of comparing the different layouts. The items excluded from the estimate are:

- Preliminaries, Control of Traffic and Sediment Erosion Control,
- Signage and linemarking,
- Stormwater and service relocations,
- Footpaths and kerb ramps,
- Earthworks; and,
- Demolition of existing Old Cooma Road.

The opinion of probable costs provided in Table 5 has adopted the below assumptions:

- The roundabout will be a rigid pavement,
- No landscaping or landscape treatments in the centre of the roundabout has been accounted for,
- The signalised intersection will include deep lift pavement where traffic loops are required,
- The priority intersection, seagull intersection and signalised intersection includes full depth pavement reconstruction of Old Cooma Road; and,
- Pavement areas and kerb lengths are determined based on intersection geometry depicted on sketches CX017, CX018, CX019 and CX031.

Table 5: Opinion of Probable Cost Comparison

	Roundabout	Priority Intersection	Seagull Intersection	Signalised Intersection
Kerb	$20,000	$21,800	$23,800	$21,900
Concrete Median	$18,900	$68,000	$40,700	$97,600
Pavement	$333,300	$248,600	$331,000	$314,700
Concrete Jointing	$123,100	-		
Signals				$100,000
Total (Ex GST)	$495,300	$338,400	$395,500	$534,200

A supplementary opinion of probable cost has been included in Table to identify the additional total costs required to include a bypass lane for both the roundabout intersection option and the signalised intersection option. The below breakdown does not account for any land acquisition costs or augmentation to the Fernleigh Drive intersection required to accommodate the bypass lane arrangements.

Table 6: Opinion of Probable Cost Comparison Bypass Lanes

	Roundabout with Bypass Lane	Signalised Intersection with Bypass Lane
Extra Over Cost (ex GST)	$85,000	$90,000

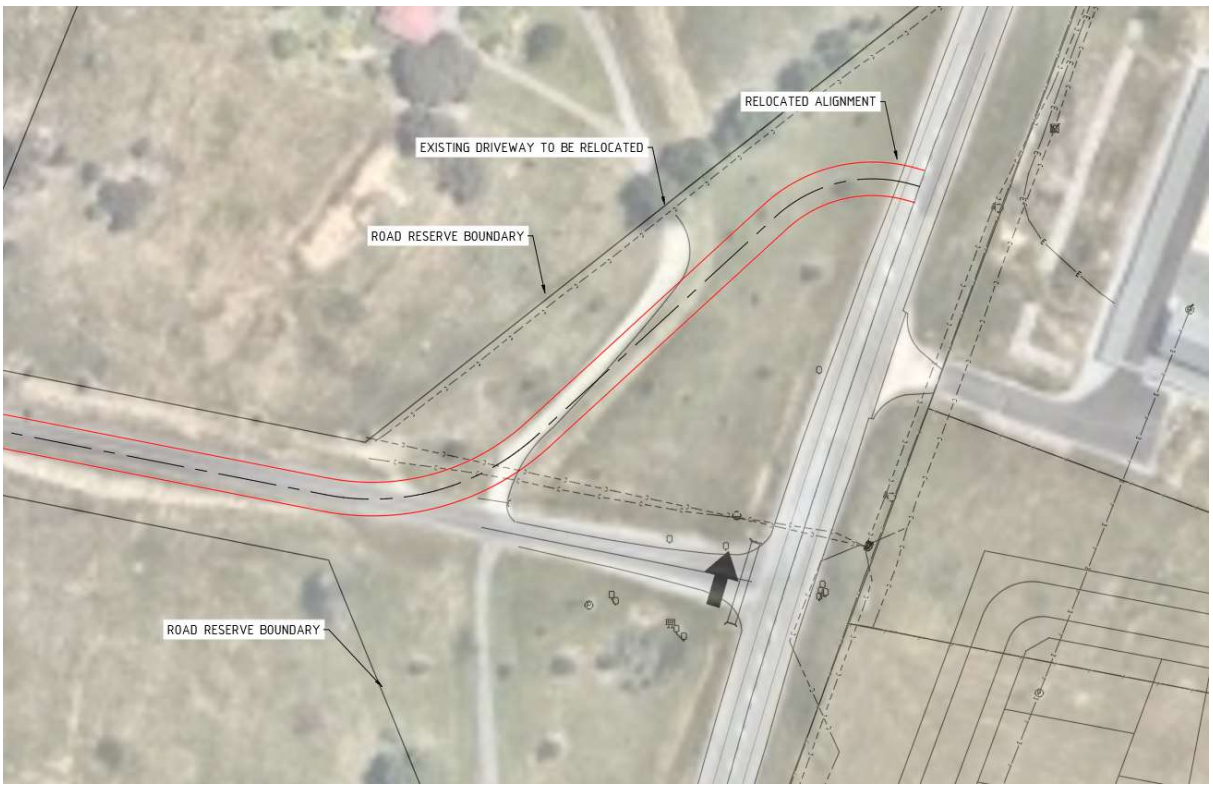
6. INTERSECTION RELOCATION

The intersection assessment identified the proximity of Bunyip Drive and Fernleigh Drive was a limiting factor to the intersections with bypass lanes. The separation of these two intersections is currently 230m. If an acceleration lane was to be accommodated the separation between the two intersections onto Old Cooma Road would need to increase by approximately 100m to a separation of 330m.

6.1 Relocating Fernleigh Drive:

- The road reserve provision allows for a 100m relocation of the intersection
- Existing driveway access onto Fernleigh would be relocated to the amended Fernleigh Drive location
- Formalised road side swale along Old Cooma Road and a new culvert crossing would be introduced
- Street trees located within the road reserve would require removal
- The anticipated cost to relocate Fernleigh Drive is approximately $150,000 (excluding GST)

Figure 7: Fernleigh Drive Realignment Option



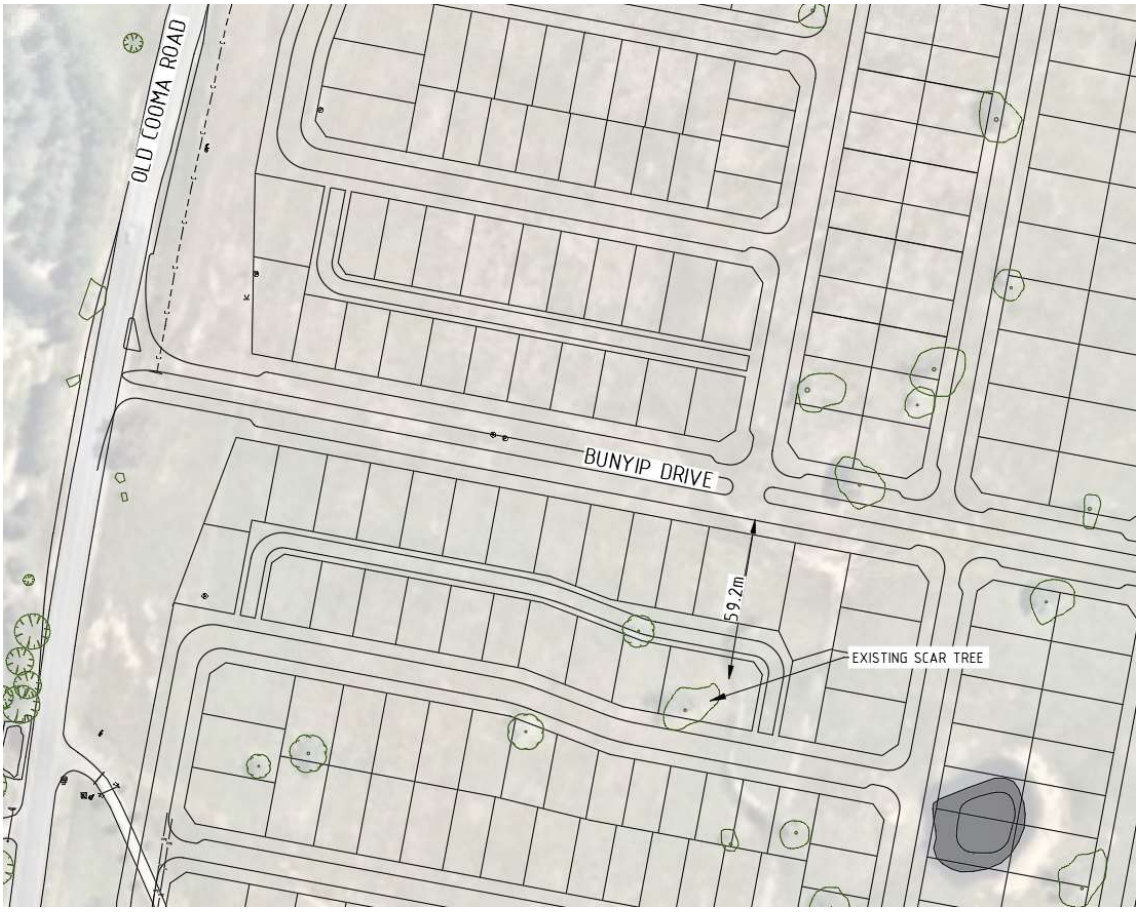
6.2 Relocating Bunyip Drive

- The current Bunyip Drive intersection was chosen to be centrally located in NH3 in accordance with best practice urban design principles of legibility, walkability and utilisation of the current site features, such as topography. The current Bunyip Drive location creates sections of about 220m

long on each side of the road. Moving the road 100m to the south will result in very short sections on the southern side of Bunyip Drive and long sections of about 320m on the northern side. These longer sections would not be compliant with the DCP and a break in the sections would need to be provided. However, given the topography, breaks in these longer sections would not be achievable as the middle of the section is at the highest point. Creation of longer section on the north side of Bunyip Drive would significantly compromise the urban design principles that the NH3-5 Structure Plan and proposed NH3-5 DA layout set out to achieve.

- The shifting of Bunyip Drive further south will impact on the culturally significant scar tree that has been retained in the current layout, shown in Figure 8 below.
- An existing farm dam located within the current Old Cooma Road road reserve would need to be removed and upstream catchments managed through road side swales along Old Cooma Road.
- Additional trees will require removal along the western verge of Old Cooma Road

Figure 8: Scar Tree Proximity to Bunyip Drive's Current Alignment



7. OLD COOMA ROAD/ BUNYIP DRIVE SUMMARY

7.1 Traffic

A summary of the intersection performance for the four assessed layouts is provided in Table 7. The give-way intersection form performs the best of the options. The give way intersection operates at a Level of Service A with low delays. The introduction of a roundabout or traffic signals increases the typical delay and maximum delay for drivers. At the level of traffic, the give way intersection control is the most efficient as there are frequent gaps in traffic – the roundabout or signals require more traffic to wait for gaps or signals to change.

Table 7: Intersection Performance By Different Intersection Layouts

Intersection layout	Performance Metric	Development Application		Planning Proposal	
		AM peak	PM peak	AM Peak	PM Peak
Priority	DoS	0.40	0.34	0.40	0.37
	Delay	9.0s	9.7s	9.0s	9.8s
	LoS	A	A	A	A
Roundabout	DoS	0.37	0.45	0.37	0.44
	Delay	13.0s	12.0s	13.0s	12.1s
	LoS	A	A	A	A
Roundabout with bypass lane	DoS	0.24	0.45	0.24	0.44
	Delay	12.0s	11.6s	12.0s	11.6s
	Los	A	A	A	A
Signalised intersection	DoS	0.39	0.34	0.39	0.35
	Delay	20.2s	17.4s	20.2s	18.1s
	LoS	B	B	B	B
Signalised intersection with a bypass lane	DoS	0.28	0.34	0.28	0.35
	Delay	12.3s	15.7s	12.3s	16.3s
	LoS	A	B	A	B

Source: SCT Consulting, 2021

Note that the delay is based on worst movement for priority and roundabout and based on the average for signal-controlled intersections; DoS is based on worst movement for all types of intersections

8. OLD COOMA ROAD INTERSECTIONS CUMULATIVE ANALYSIS

Old Cooma Road and the four intersecting roads; Googong Road, Wellsvale Drive, Fernleigh Drive and Bunyip Drives have been assessed to identify the impact of travel time along Old Cooma Road following the development of NH345. Two modelling scenarios were proposed for comparison, being:

- NH1 and NH2 only
- NH1, NH2 and NH345.

8.1 Forecast Traffic Volumes by the intersections

Intersection volumes were extracted from the TRACKS model discussed in *Working Paper 1: TRACKS Model Updates Report*. The traffic volumes under the development application scenario were adopted based on the yield after the subdivision development application for NH345.

A total of four intersections were included in a study area for Old Cooma Road, totalling over 3 km. They include:

- Old Cooma Road/Googong Road (signal)
- Old Cooma Road/Wellsvale Drive (signal)
- Old Cooma Road/Fernleigh Drive (give way)
- Old Cooma Road/Bunyip Drive (signal without bypass as worst case).

Traffic volumes are provided in the format supplied by TRACKS from Table 8 to Table 11. The volumes are up to 2,700 vehicles per hour per intersection approach. It is noted that there will be only through traffic (calculated from Fernleigh Drive intersection) for the intersection of Old Cooma Road/Bunyip Drive in the NH1 and NH2 only scenario assuming Bunyip Drive does not exist.

Table 8: Ultimate peak hour traffic forecasts at the intersection of Old Cooma Road/Googong Road

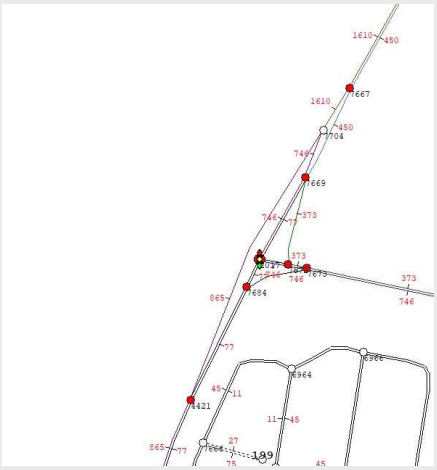
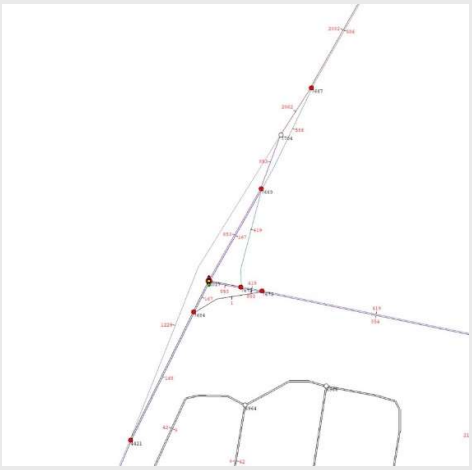
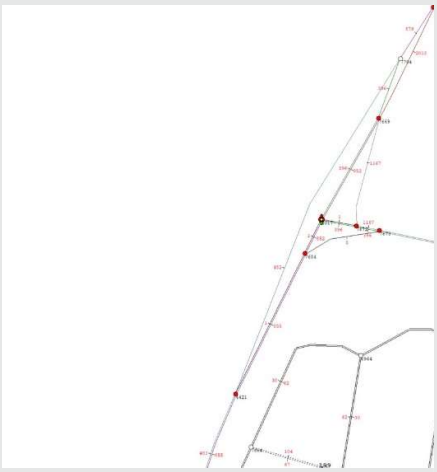
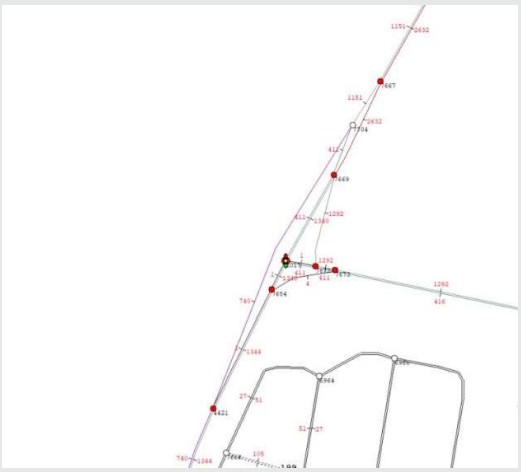
Scenario	NH1 & 2	NH1 & NH2 + NH345
AM		
PM		

Table 9: Ultimate peak hour traffic forecasts at the intersection of Old Cooma Road/Wellsvale Drive

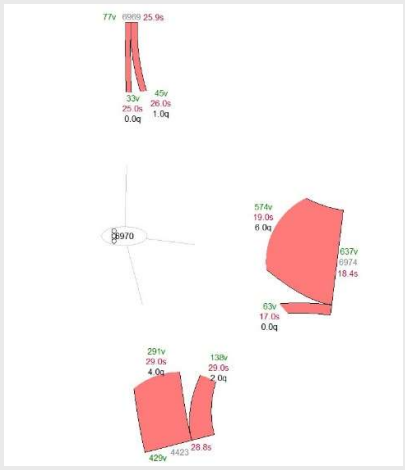
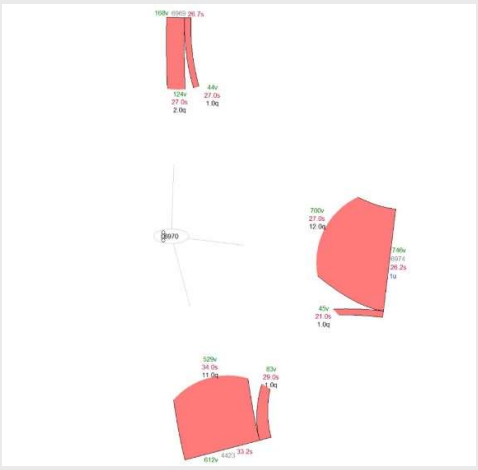
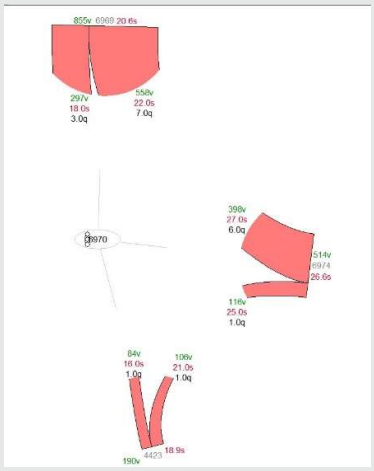
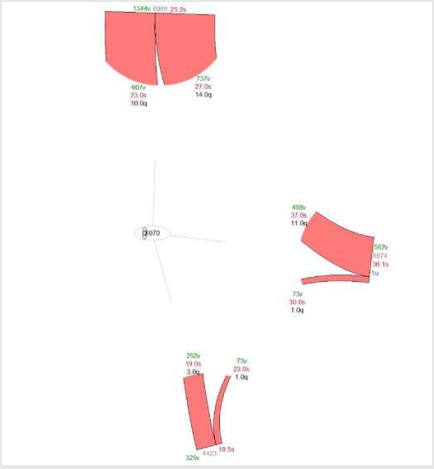
Scenario	NH1 & 2	NH1 & NH2 + NH345
AM		
PM		

Table 10: Ultimate peak hour traffic forecasts at the intersection of Old Cooma Road/Fernleigh Drive

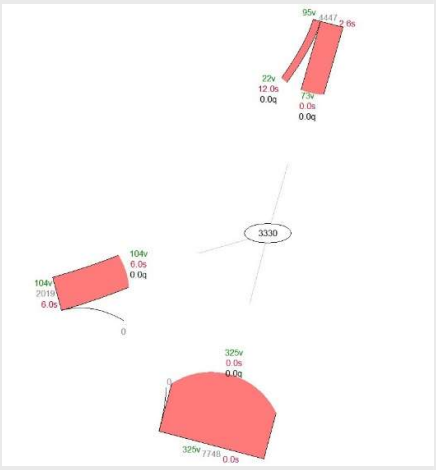
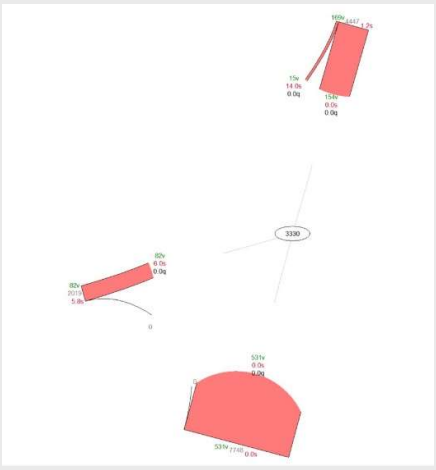
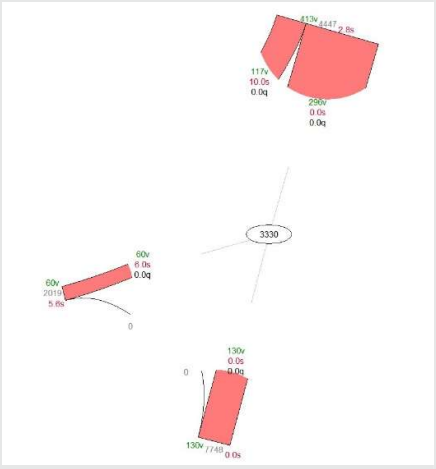
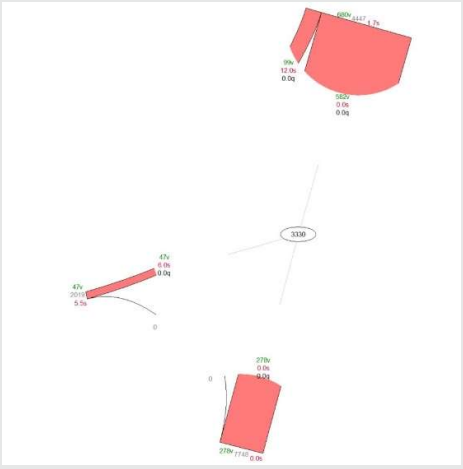
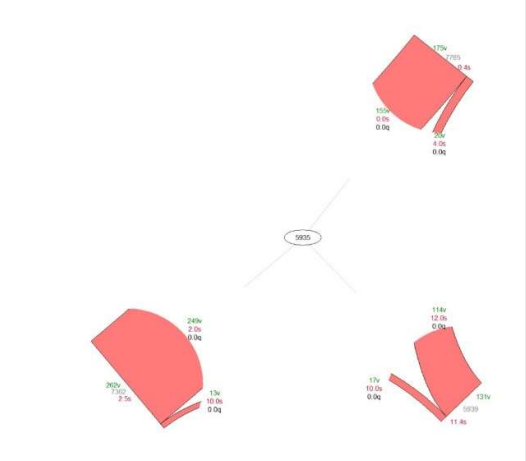
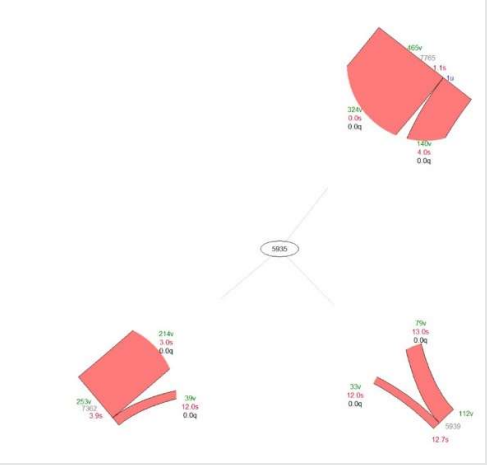
Scenario	NH1 & 2	NH1 & NH2 + NH345
AM		
PM		

Table 11: Ultimate peak hour traffic forecasts at the intersection of Old Cooma Road/Bunyip Drive

Scenario	NH1 & 2	NH1 & NH2 + NH345
AM	N/A	
PM	N/A	

8.2 Intersection Performance

Traffic modelling was undertaken using SIDRA 9.0 for the four intersections, which were connected in a network to evaluate the intersection performance and travel time impact. The below assumptions were adopted for the modelling:

- Based on SCATS signal timing data on 20 September 2020 for the two existing signal intersections, it is acknowledged that the two sites are not coordinated and running 'isolated'. There are no fixed cycle times (ranging from 40 seconds to 70 seconds). This is a typical operating mode for signals that are long distances away from each other and are operating with low delays.

- Signals and pedestrian crossings have been removed for the left turn slip lane from the north to the east for Old Cooma Road/Googong Road and Old Cooma Road/Wellsvale Drive intersections. These pedestrian crossings are almost never called during peak periods due to the low pedestrian demand, so don't have an impact on signal operations.

The intersection layouts are shown in Table 12. A summary of the intersection performance is provided in Table 13.

Table 12: Intersection Layouts

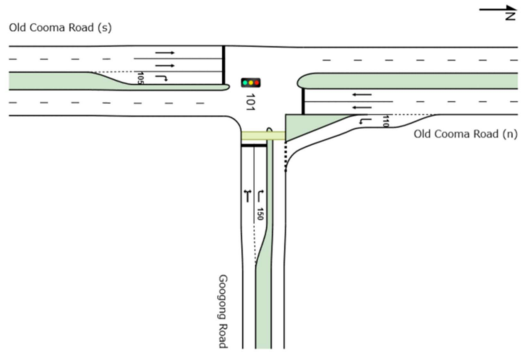
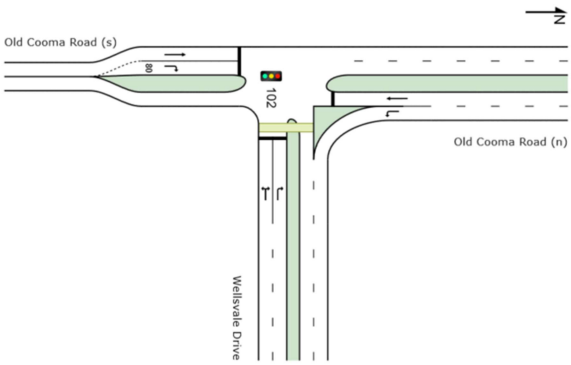
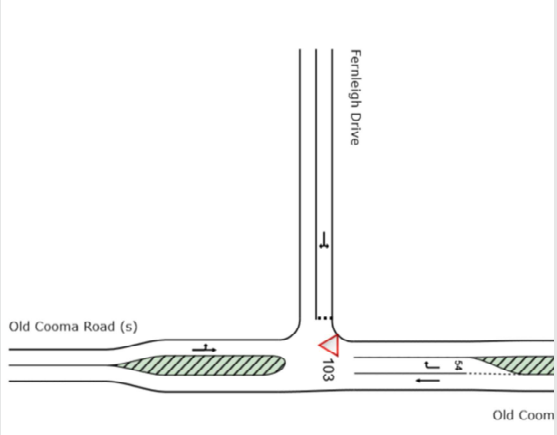
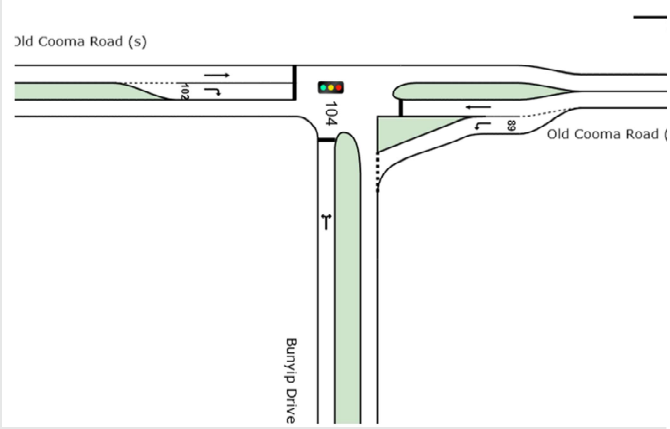
Layouts	
Old Cooma Road/Googong Road	**Old Cooma Road/Wellsvale Drive**
	
Old Cooma Road/ Fernleigh Drive	**Old Cooma Road/ Bunyip Drive**
	

Table 13: Intersection Layouts

Intersections	Performance Metric	NH1 and NH2		NH1 and NH2 + NH345	
		AM peak	PM peak	AM peak	PM peak
Old Cooma Road/Googong Road	DoS	0.86	0.82	0.78	0.94
	Delay	16.3s	14.4s	18.1s	15.1s
	LoS	**B**	**A**	**B**	**B**
Old Cooma Road/Wellsvale Drive	DoS	0.72	0.77	0.85	0.85
	Delay	17.8s	16.3s	19.4s	19.5s
	LoS	**B**	**B**	**B**	**B**
Old Cooma Road/Fernleigh Drive	DoS	0.18	0.17	0.30	0.33
	Delay	8.2s	8.6s	9.4s	11.3s
	LoS	**A**	**A**	**A**	**A**
Old Cooma Road/Bunyip Drive	DoS	Intersection doesn't exist in this scenario		0.58	0.50
	Delay			12.8s	11.9s
	LoS			**A**	**A**

Source: SCT Consulting, 2021

Note that the delay is based on worst movement for priority and roundabout and based on the average for signal-controlled intersections; DoS is based on worst movement for all types of intersections.

All intersections have good performance with a Level of Service B and above, before and after NH345, as evidenced by the constant LoS across the two scenarios. The only exception is Old Cooma Road/Googong Road intersection where the subdivision of NH345 slightly increases the delay, resulting a LoS A to B. However, it should be noted that the delay has been already 0.1 seconds less than the higher end of the band (14.5 seconds) for LoS A before the subdivision.

The longest queue occurs on the left turn slip lane at the intersection of Googong Road/Old Cooma Road (north to east) for PM peak hour when the NH345 is open. However, the queue length (139 m) is fully accommodated within the turning bay (140 m).

A northbound route and a southbound route were specified along Old Cooma Road (between Bunyip Drive and Googong Road) for AM peak and PM peak hour, respectively. This is to identify the implication of the travel time and control delay for a wider community and the road users on Old Cooma Road before and after the introduction of NH345 (Figure 9 and Figure 10).

Figure 9 Route for AM peak hour

Figure 10 Route for PM peak hour

8.2.1 Average travel speed

According to *AGTM03-17 Part 3 Traffic Study and Analysis Methods,* the traffic conditions associated with the various levels of service for urban and suburban arterial roads with interrupted flow conditions are described in HCM 2016 (Table 14):

Table 14 Level of Service for urban and suburban arterial roads, speed metrics in *italics*

Level of Service	Description
A	**Primarily free-flow operation.** Vehicles are completely unimpeded in their ability to manoeuvre within the traffic stream. Control delay at the boundary intersections is minimal. *The travel speed exceeds 80% of the base free-flow speed (BFFS).*
B	**Reasonably unimpeded operation.** The ability to manoeuvre within the traffic stream is only slightly restricted and control delay at the boundary intersections is not significant. *The travel speed is between 67% and 85% of the BFFS.*
C	**Stable operation.** The ability to manoeuvre and change lanes at mid-segment locations may be more restricted than at LOS B. Longer queues at the boundary intersections may contribute to lower travel speeds. *The travel speed is between 50% and 67% of the BFFS.*
D	**A less stable condition** in which small increases in flow may cause substantial increases in delay and decreases in travel speed. This operation may be due to adverse signal progression, high volume, or inappropriate signal timing at the boundary intersections. *The travel speed is between 40% and 50% of the BFFS.*
E	**Unstable operation and significant delay.** Such operations may be due to some combination of adverse progression, high volume, and inappropriate signal timing at the boundary intersections. *The travel speed is between 30% and 40% of the BFFS.*

Source: AGTM03-17 Part 3 Traffic Study and Analysis Methods, 2020
BFFS stands for Base Free Flow Speed and is assumed to be the speed limit

The resultant travel speed and speed efficiency of the two routes before and after NH345 are compared in Table 15.

Table 15 Travel speed (2031 peak hours)

Route	Scenario	Travel speed	Speed Efficiency	Difference due to NH345 delivery
AM peak in northbound direction	NH1 and NH2	71.6 km/h	0.90	-11.2%
	NH1 and NH2 + NH345	63.6 km/h	0.80	
PM peak in southbound direction	NH1 and NH2	66.3 km/h	0.83	-7.2%
	NH1 and NH2 + NH345	61.5 km/h	0.77	

The development of NH345 would result in speed reduction on Old Cooma Road, i.e. 11.2 per cent and 7.2 per cent, respectively for northbound in the AM peak and southbound in the PM peak hour. When NH345 is fully developed, the speed efficiency (travel speed to speed limit ratio) are 0.8 and 0.77 for AM peak and PM peak hour, which are located in LoS A and B category. This indicates limited speed reduction for the Old Cooma Road users as a result of the development of NH345.

8.2.2 Delays

The average control delay for the route in the AM peak and PM peak would increase by around 1.5 to 5.5 seconds after the development of NH345. This is a marginal increase over a 3 km section of Old Cooma Road during the peak hours (Table 16).

Table 16 Control delay (2031 peak hours)

Route	Scenario	Average control delay	Difference
AM peak in northbound direction	NH1 and NH2	5.5 seconds	+5.4 seconds
	NH1 and NH2 + NH345	10.9 seconds	
PM peak in southbound direction	NH1 and NH2	8.7 seconds	+1.5 seconds
	NH1 and NH2 + NH345	10.2 seconds	

9. CONCLUSION

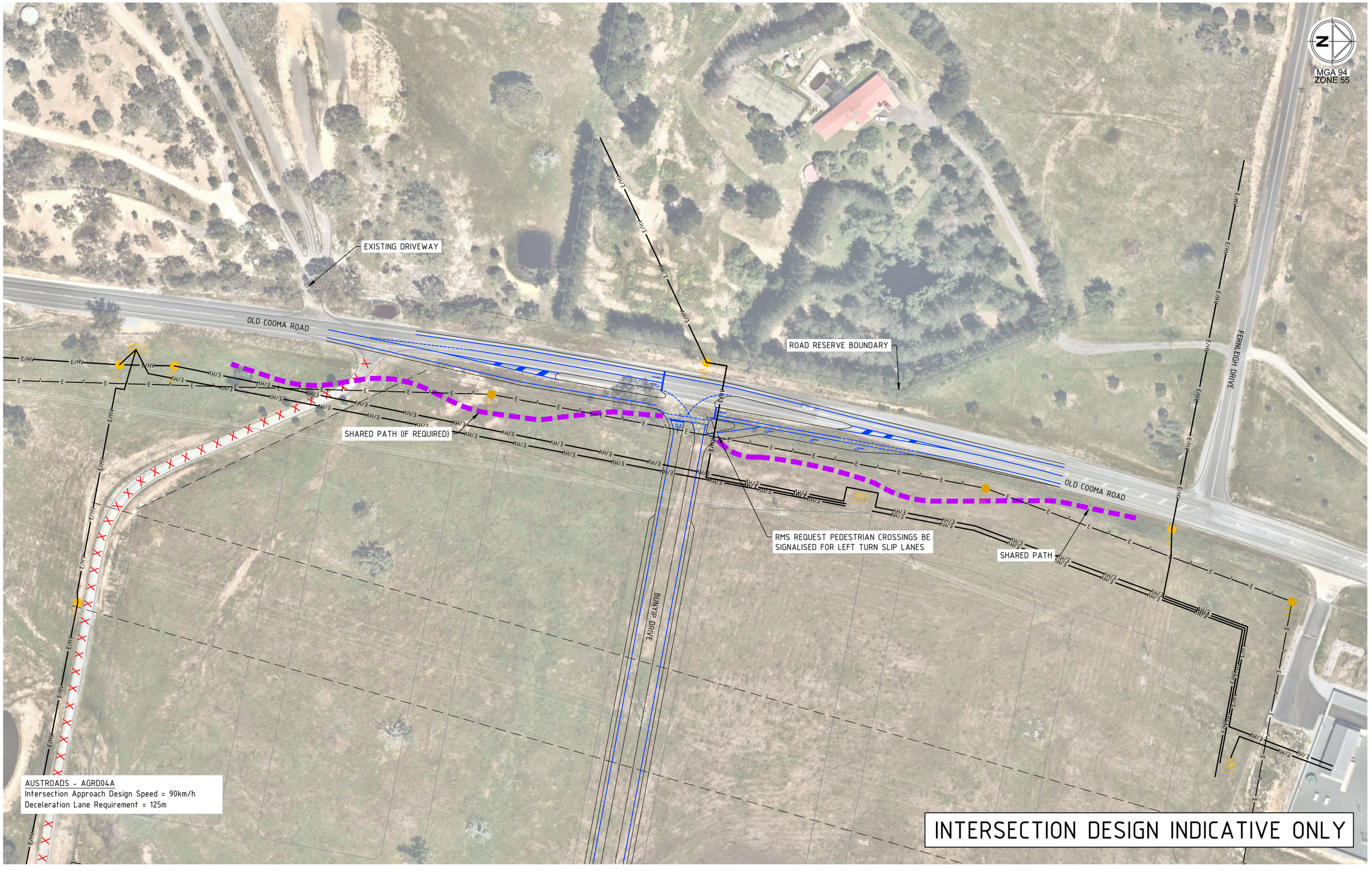
This memo considers the feasibility of various layout options for the intersection of Old Cooma Road / Bunyip Drive, based on forecast ultimate Googong traffic volumes.

SIDRA modelling forecasts that the intersection would operate satisfactorily as a priority (give-way), roundabout or traffic signals, during peak hours of Googong's full development. However, traffic signals would not be warranted at this location according to *Traffic Signal Design – Section 2 Warrants.*

The priority (give-way) intersection operates with the lowest delays of all the options with no superior justification for the intersection of Old Cooma Road/Bunyip Drive to be signalised.

Therefore, it is recommended a priority give-way intersection is provided at the intersection of Old Cooma Road / Bunyip Drive as it has the lowest levels of delay and promotes flexibility for staging the intersection should traffic signals be warranted in the future. A priority controlled intersection formalises and reinforces road rules as well as assigns priority to Old Cooma Road without significant impact or alterations to the existing road reserve.

Additionally a comparison of the corridor performance of Old Cooma Road before and after the development of NH345 was reviewed. It is concluded that there is limited reduction of travel speed and increase of control delay along Old Cooma Road as a result of the development NH345 including the new intersection of Bunyip Drive. Therefore it is expected that the impact of the subdivision is at a level to be accepted by the local community and a wider user group of Old Cooma Road.



DRAFT

Rev	Amendments	Approved	Date

1:750@A1
SCALE
1:1500@A3

0 7.5 15 22.5 30 37.5

© Spiire Australia Pty Ltd All Rights Reserved
This document is produced by Spiire Australia Pty Ltd solely for the benefit of and use by the client in accordance with the terms of the retainer. Spiire Australia Pty Ltd does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by third party on the content of this document.

spiire
Suite 5, 243 Northbourne Ave Lyneham 2602
Australian Capital Territory Australia T 61 2 6102 1000
spiire.com.au ABN 55 050 029 635

GOOGONG

Designed Checked

Authorised Date

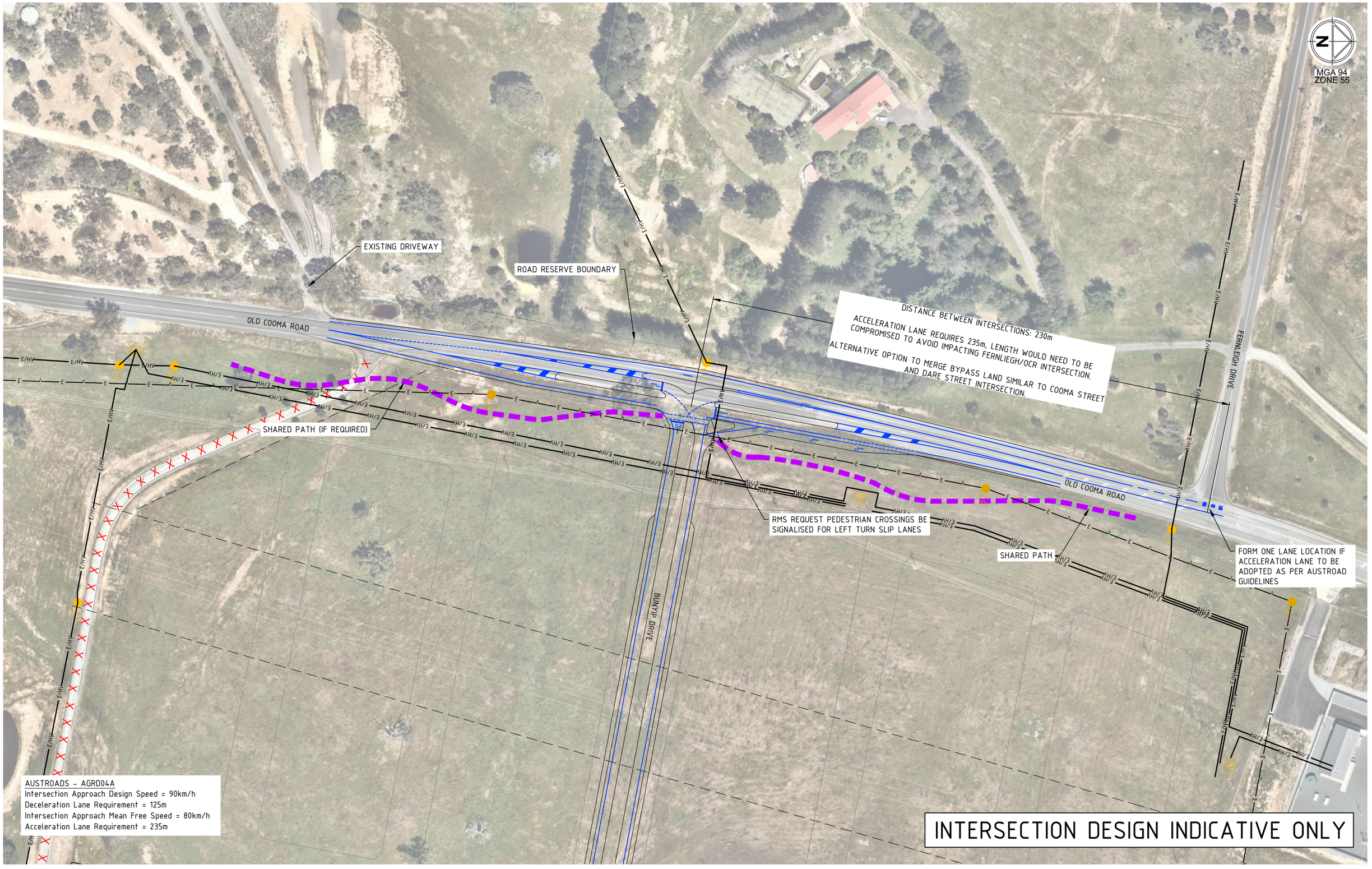
GOOGONG NH345 SKETCHES

OLD COOMA ROAD INTERSECTION OPTIONS
SIGNALISED INTERSECTION

QPRC
GOOGONG TOWNSHIP PTY LTD

Drg No **308534CX017** Rev **----**

file name 308534CX016 OLD COOMA ROAD INTERSECTIONS.dwg layout name CX017 plotted by Chelsea Corcoran
file location G:\30\308534\Civil\ACAD\Sketches plot date 13/04/2021 3:42 PM Sheet of Sheets



DRAFT

Rev	Amendments	Approved	Date

1:750@A1
SCALE
1:1500@A3
0 7.5 15 22.5 30 37.5

© Spiire Australia Pty Ltd All Rights Reserved
This document is produced by Spiire Australia Pty Ltd solely for the benefit of and use by the client in accordance with the terms of the retainer. Spiire Australia Pty Ltd does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by third party on the content of this document.

spiire
Suite 5, 243 Northbourne Ave Lyneham 2602
Australian Capital Territory Australia T 61 2 6102 1000
spiire.com.au ABN 55 050 029 635

GOOGONG

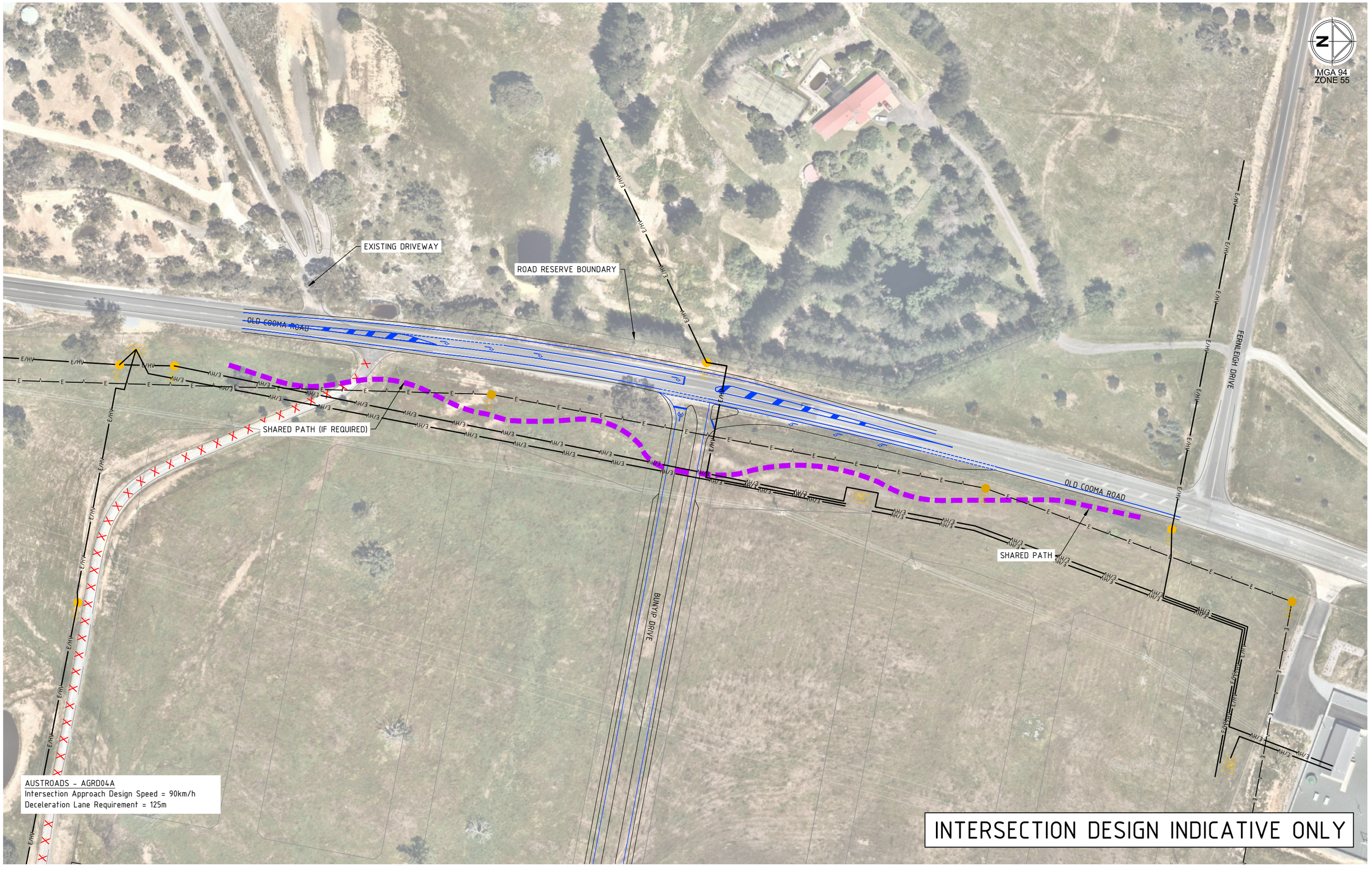
Designed Checked
Authorised Date

GOOGONG NH345 SKETCHES

OLD COOMA ROAD INTERSECTION OPTIONS
SIGNALISED INTERSECTION WITH AUXILIARY BYPASS LANE
QPRC
GOOGONG TOWNSHIP PTY LTD

Drg No **308534CX018** Rev **----**

file name 308534CX016 OLD COOMA ROAD INTERSECTIONS.dwg layout name CX018 plotted by Chelsea Corcoran
file location G:\30\308534\Civil\ACAD\Sketches plot date 13/04/2021 3:42 PM Sheet of Sheets



DRAFT

Rev	Amendments	Approved	Date

1:750@A1 SCALE 1:1500@A3 — 0 7.5 15 22.5 30 37.5

© Spiire Australia Pty Ltd All Rights Reserved
This document is produced by Spiire Australia Pty Ltd solely for the benefit of and use by the client in accordance with the terms of the retainer. Spiire Australia Pty Ltd does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by third party on the content of this document.

spiire
Suite 5, 243 Northbourne Ave Lyneham 2602
Australian Capital Territory Australia T 61 2 6102 1000
spiire.com.au ABN 55 050 029 635

GOOGONG

Designed — Checked

Authorised — Date 23.03.2021

GOOGONG NH345 SKETCHES

OLD COOMA ROAD INTERSECTION OPTIONS
GIVE WAY T-INTERSECTION
QPRC
GOOGONG TOWNSHIP PTY LTD

Drg No **308534CX019** Rev **A**

file name 308534CX016 OLD COOMA ROAD INTERSECTIONS.dwg layout name CX019 plotted by Chelsea Corcoran
file location \\spiire.com.au\candata\Data3\30\308534\Civil\ACAD\Sketches plot date 23/03/2021 10:06 AM Sheet of Sheets

DRAFT

Rev	Amendments	Approved	Date

1:500@ A1 SCALE 1:1000@ A3 — 0 5 10 15 20 25

© Spiire Australia Pty Ltd All Rights Reserved
This document is produced by Spiire Australia Pty Ltd solely for the benefit of and use by the client in accordance with the terms of the retainer. Spiire Australia Pty Ltd does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by third party on the content of this document.

spiire
Suite 5, 243 Northbourne Ave Lyneham 2602
Australian Capital Territory Australia T 61 2 6102 1000
spiire.com.au ABN 55 050 029 635

GOOGONG

Designed | Checked | Authorised | Date 23.03.2021

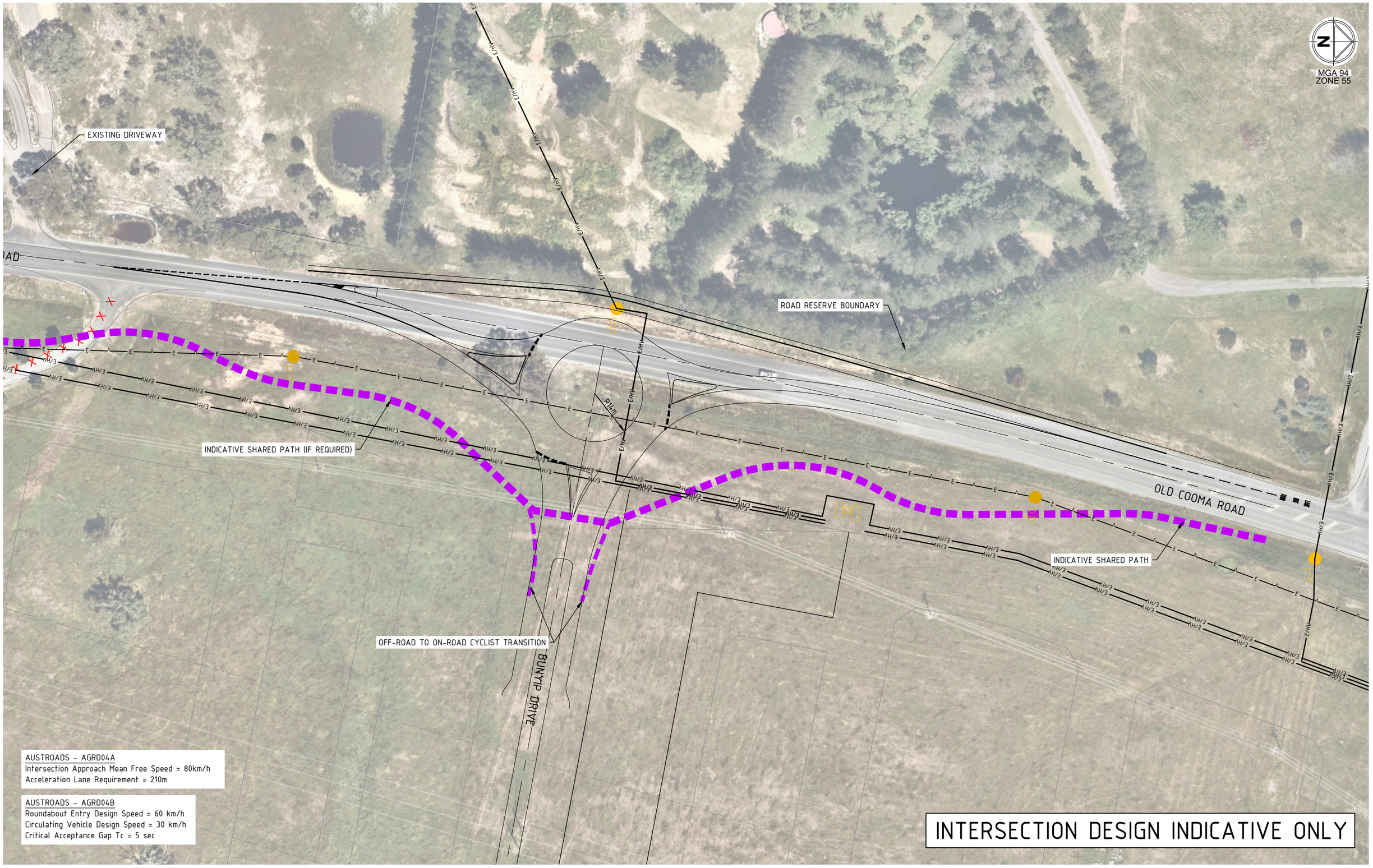
GOOGONG NH345 SKETCHES

OLD COOMA ROAD INTERSECTION OPTIONS

QPRC
GOOGONG TOWNSHIP PTY LTD

Drg No **308534CX031** Rev **A**

file name 308534CX031 OLD COOMA ROAD INTERSECTIONS.dwg layout name CX031 plotted by Chelsea Corcoran
file location \\spiire.com.au\candata\Data\30\308534\Civil\ACAD\Sketches plot date 23/03/2021 10:01 AM Sheet of Sheets



DRAFT

Rev	Amendments	Approved	Date

1:500@ A1 SCALE 1:1000@ A3 — 0 5 10 15 20 25

© Spiire Australia Pty Ltd All Rights Reserved
This document is produced by Spiire Australia Pty Ltd solely for the benefit of and use by the client in accordance with the terms of the retainer. Spiire Australia Pty Ltd does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by third party on the content of this document.

spiire
Suite 3, 243 Northbourne Ave Lyneham 2602
Australian Capital Territory Australia T 61 2 6102 1000
spiire.com.au ABN 55 050 029 635

GOOGONG

Designed | Checked | Authorised | Date 28-06-2021

GOOGONG NH345 SKETCHES

OLD COOMA ROAD INTERSECTION OPTIONS

QPRC
GOOGONG TOWNSHIP PTY LTD

Drg No **308534CX032** Rev **A**

file name 308534CX031 OLD COOMA ROAD INTERSECTIONS.dwg layout name CX032 plotted by Lachlan O'Reilly
file location \\Spiire\canberra\Data\30\308534\Civil\CAD\Sketches plot date 28/06/2021 1:29 PM Sheet of Sheets