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Project title	Karratha Terrace/ Hedland Place Intersection, Karratha	Job number	243023-04
cc		File reference	
Prepared by	Catherine Deady Darryl Patterson	Date	7 February 2017
Subject	Karratha Terrace/ Hedland Place Road Safety Review		

1 Introduction

Arup have been engaged by Landcorp to undertake a road safety review of two intersection treatments for the intersection of Karratha Terrace and Hedland Place, located in the City of Karratha. The current intersection arrangement comprises of a left in, left out treatment for Hedland Place traffic, however concerns have been raised in the community regarding the impact of restricting movements on accessibility for local businesses and residents. On this basis, a safety review has been undertaken of an all movements intersection at the same location.

1.1 Site Location

The intersection of Karratha Terrace and Hedland Place is located in Karratha. The intersection is located within close proximity to a Karratha City shopping centre, situated to the south of the intersection and St Paul's primary school to the east. Searipple Road is parallel to the intersection of Karratha Terrace and Searipple Road where a roundabout treatment is proposed. Figure 1 highlights where the intersection is located in relation to the existing road layout.

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Figure 1: Existing intersection configuration at Karratha Terrace/ Hedland Place, Karratha

1.2 Proposed Intersection Treatments

Two intersection treatments have been considered and designed for the Karratha Terrace/ Hedland Place intersection, which include the following:

- Priority Control T-junction (all intersection movements); and
- Left in and left out (LILO) that has recently been constructed.

The priority control T-junction allowing all movements at the Karratha Terrace/ Hedland Place intersection is shown in Figure 2.

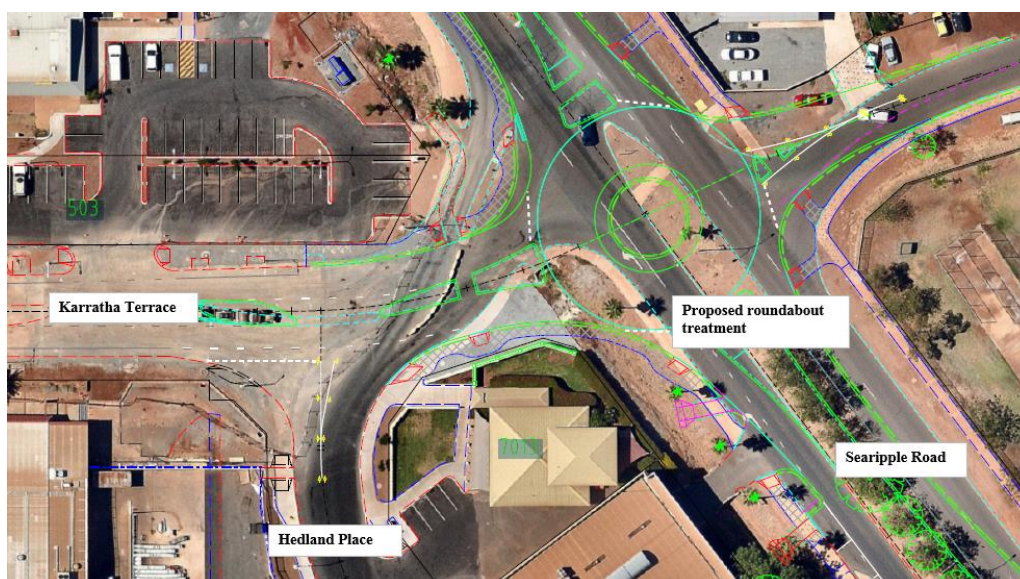


Figure 2: Priority control intersection at Karratha Terrace/ Hedland Place (source: Wood & Grieve Engineers design)

The current LILO treatment is shown in Figure 3.

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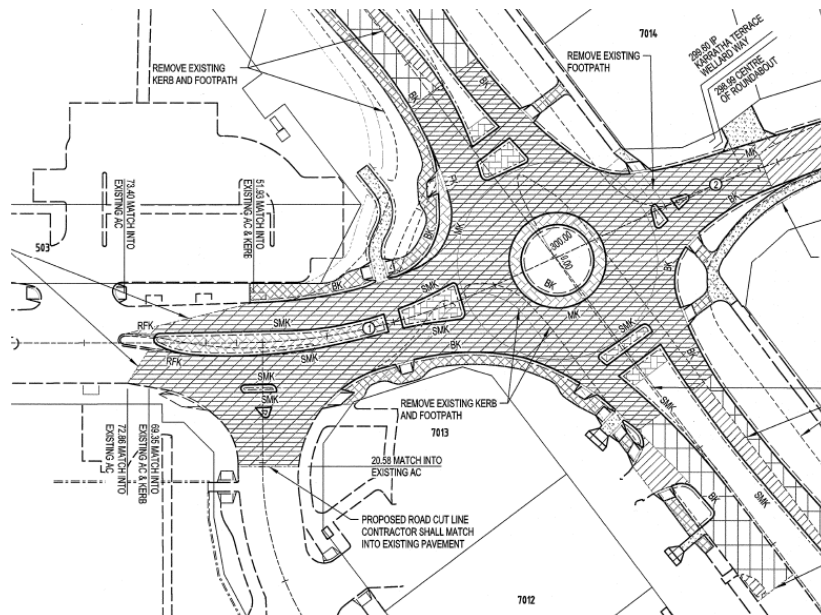


Figure 3: Left in/ left out treatment at the Karratha Terrace/ Hedland Place intersection (source: Wood & Grieve Engineers design)

2 Safety Review

The purpose of this safety review is to summarise the potential road safety risks associated with the proposed designs for the Karratha Terrace/ Hedland Place intersection. This review investigates the impacts of sightlines at the intersection, intersection spacing, autotrack assessment, pedestrian access and queue lengths (based on SIDRA Analysis). The queue length information will be referenced from previous work completed by Arup for the roundabout treatment at Karratha Terrace and Searipple Road.

2.1 Intersection Sight Distance

Safe Intersection Sight Distance (SISD) must be taken into account at the design stage of a project to ensure a safe road layout is being implemented on the network. The *Austrroads Guide to Road Design Part 4A – Unsignalised and Signalised Intersections* states that SISD provides sufficient distance for a driver of a vehicle on a major road to observe a vehicle on a minor road approaching into a collision situation. This would generally apply for left and right turning traffic.

Site distance for the left turn movement to the exiting westbound arm of the roundabout is approximately 45 metres, whilst for right turning traffic the sight distance (to the left) is approximately 63 metres. Refer to Figure 4 that demonstrates the SISD for the right turn at Karratha Terrace/ Hedland Place.

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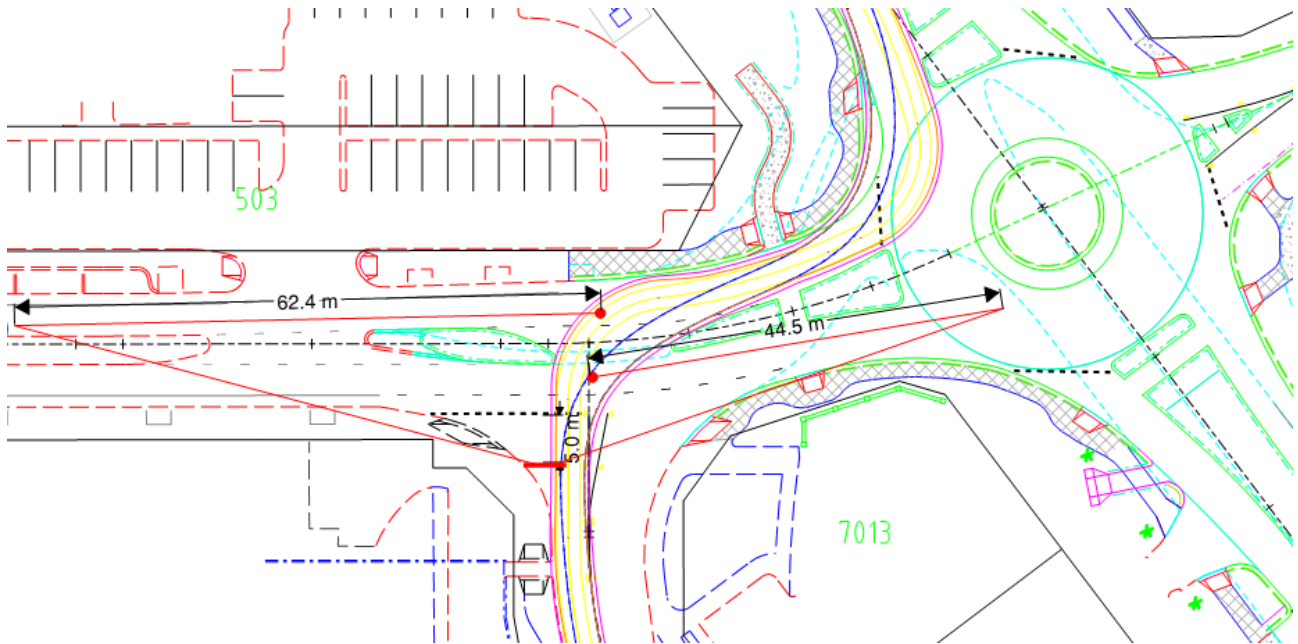


Figure 4: Safe Intersection Sight Distance for the right turn at Karratha Terrace/ Hedland Place

At a 40km/h speed, a SISD of 73 metres is required. This increases to 97 metres for 50km/h. Figure 5 illustrates SISD at a standard priority control intersection as stated in the Austroad Guidelines.

The minimum gap site distance (MGSD) of 56 metres is required for left turning traffic in a 40km/h zone, however generally SISD in the previously paragraph, should govern in this case.

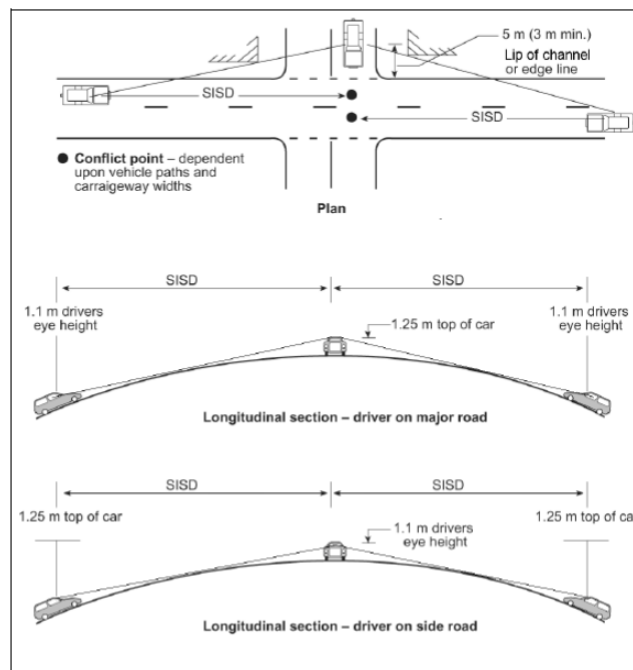


Figure 3.2: Safe intersection sight distance (SISD)

Figure 5: Safe Intersection Sight Distance (SISD) (source: Austroads Guide to Road Design – Part 4A – Unsignalised and Signalised Intersections)

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Given the constraints of sight distance to the right, the addition of a right turn movement requiring the driver to check additional sight lines to the left is not recommended on safety grounds.

2.2 Intersection Spacing

It is important to have sufficient spacing between intersections to improve traffic flow and to provide a safe and connective network. The *Liveable Neighbourhoods document (Draft 2015)* has a table that displays indicative terminating street spacing based on the road type. The Main Roads WA Functional Road Hierarchy classifies Hedland Place as an Access Road (Access Street as per the Liveable Neighbourhoods document) and Searipple Road as a Local Distributor (Neighbourhood Connector as per the Liveable Neighbourhoods document). Refer to Figure 6 showing the indicative terminating street spacing. The minimum spacing required between the two terminating roads (Hedland Place and Searipple Road) is greater than 40m which is just achieved in this instance.

Table 5: Indicative terminating street spacing

Close

Integrator Arterial through-route	Terminating route	Minimum spacing on same side of route -Unsignalised (based on left turn lane length on through route)	Minimum Left / right staggers (based on non-overlapping right turn lanes on through-route)	Right/left stagger (based on left turn lane length on through route)
Primary Distributor	Integrator A arterial	>75m (60 km/h)	>175m (60 km/h)	20m – 50m (60 km/h)
		>100m (70 km/h)	>225m (70 km/h)	20m – 70m (70 km/h)
		>125m (80 km/h)	>270m (80 km/h)	20m – 95m (80 km/h)
Primary Distributor	Integrator B arterial	>75m (60 km/h)	>175m (60 km/h)	20m – 50m (60 km/h)
		>100m (70 km/h)	>225m (70 km/h)	20m – 70m (70 km/h)
		>125m (80 km/h)	>270m (80 km/h)	20m – 95m (80 km/h)
Integrator A arterial	Integrator A arterial	>55m (50 km/h)	>140m (50 km/h)	20m – 35m (50 km/h)
		>75m (60 km/h)	>175m (60 km/h)	20m – 50m (60 km/h)
Integrator A arterial	Integrator B arterial	>55m (50 km/h)	>140m (50 km/h)	20m – 35m (50 km/h)
		>75m (60 km/h)	>175m (60 km/h)	20m – 50m (60 km/h)
Integrator A arterial	Neighbourhood connector	>55m (50 km/h)	>140m (50 km/h)	20m – 35m (50 km/h)
		>75m (60 km/h)	>175m (60 km/h)	20m – 50m (60 km/h)
Integrator B arterial	Integrator B arterial	>55m (50 km/h)	>140m (50 km/h)	20m – 35m (50 km/h)
		>75m (60 km/h)	>175m (60 km/h)	20m – 50m (60 km/h)
Integrator B arterial	Neighbourhood connector	>55m (50 km/h)	>140m (50 km/h)	20m – 35m (50 km/h)
		>75m (60 km/h)	>175m (60 km/h)	20m – 50m (60 km/h)

Local through-route	Terminating route	Minimum spacing on same side of route	Minimum left/right staggers (based on minimising corner cutting)	Right/left stagger (based on deflecting through movement on terminating route)
Neighbourhood connector	Neighbourhood connector	>40m	>40m	15m – 20m
Neighbourhood connector	Access street	>40m	>40m	15m – 20m
Access street	Access street	>20m	>20m	15m – 20m
Access street	Laneway	>20m	>20m	15m – 20m

Notes

1 – The speed in brackets is the posted speed of the through-route.

2 – Spacing is measured using route centreline to route centreline.

3 – For left/right staggers on integrator arterials, storage has been allowed for two queuing vehicles.

Where higher levels of queuing vehicles are anticipated, the spacings in the table may need to be increased accordingly.

Figure 6: Indicative Terminating Street Spacing

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The intersection spacing measurements for both of the intersection treatments are shown (in red) in Figure 7 and Figure 8.

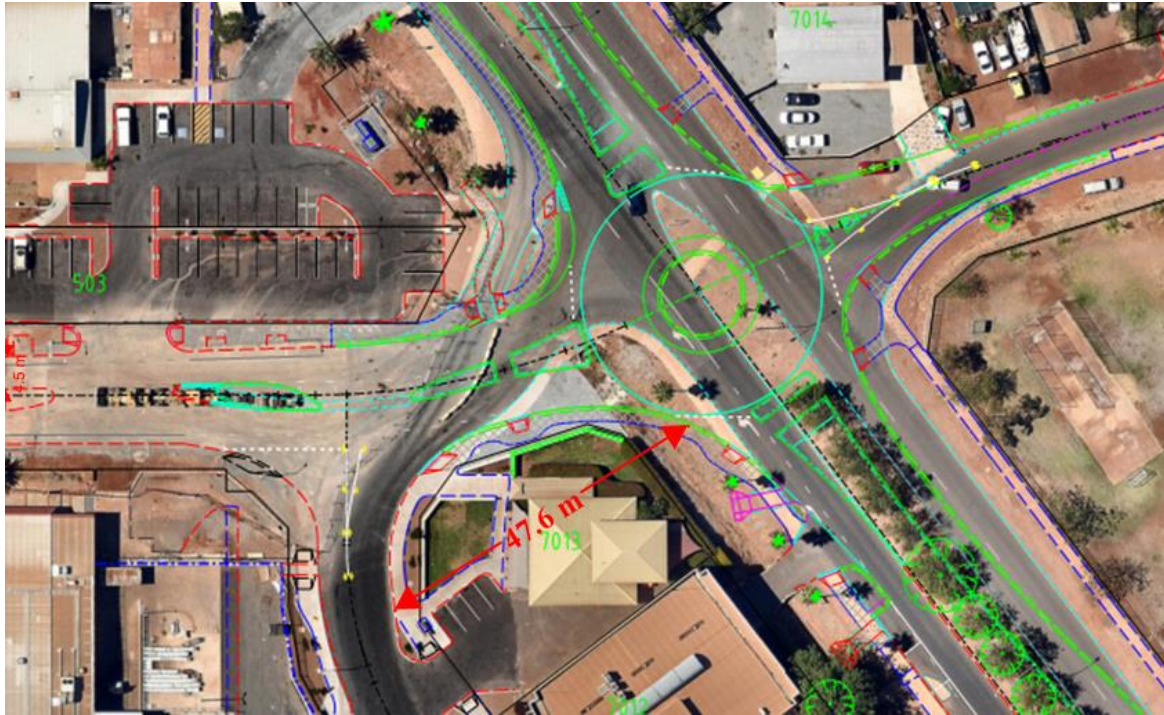


Figure 7: Intersection spacing – Priority control

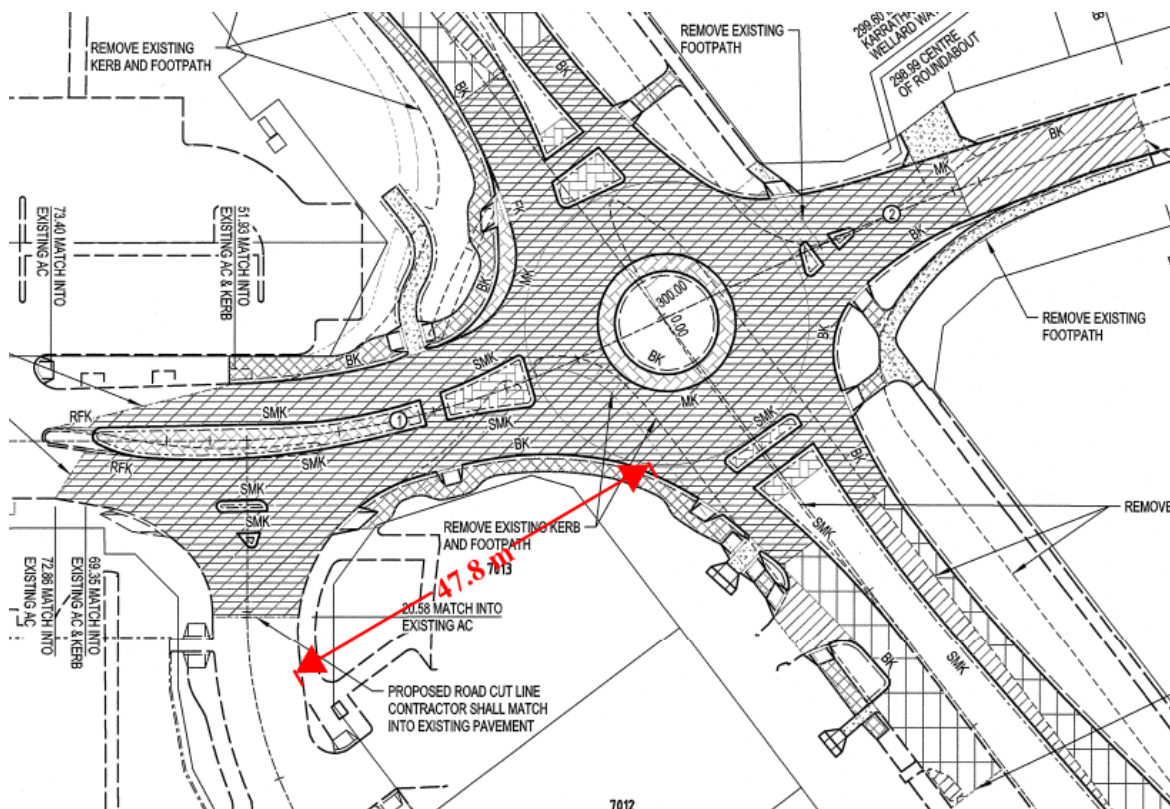


Figure 8: Intersection spacing – LILO treatment

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2.3 Autotrack Assessment

Autotrack assessments have been investigated by Wood & Grieve Engineers to understand how large vehicles (19m articulated vehicles) can undertake the right turn movements at the Karratha Terrace/ Hedland Place intersection. The right turn movement (out of Hedland Place) for the 19m artic straddles the centre line on Hedland Place, therefore encroaching on the southbound line of travel, leading to potential head-on collisions on Hedland Place. As the vehicle tracks onto Searipple Road the vehicle also overhangs the pedestrian footpath on the north/west side of Searipple Road, which is a significant safety risk to pedestrians. The autotrack assessment for this movement is shown in Figure 9.

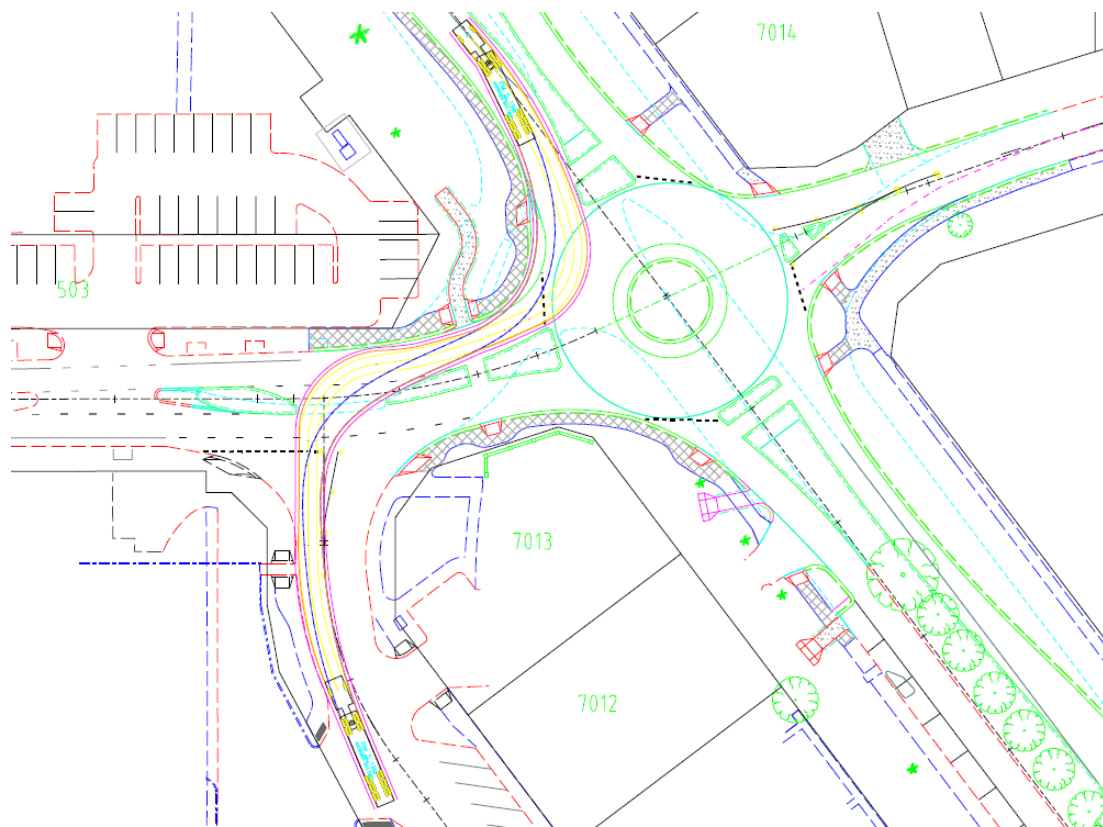


Figure 9: Autotrack Assessment – Right turn out of Hedland Place (source: Wood & Grieve Engineers)

2.4 Pedestrian Access

Safe pedestrian access is an important aspect of road design, especially when there are facilities in a local area that generate walking trips. In this case, there are two major facilities that generate walking trips, including the School (to the east) and shopping centre (to the south) of the intersection. The Karratha Terrace/ Hedland Place design treatments consider pedestrian access on both the major road, to the east of the proposed intersection, and terminating road. It is important to note that reducing the crossing distance for pedestrians at an intersection reduces the risk of pedestrian/ vehicle conflicts, especially for wheelchair users and the elderly population.

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2.5 SIDRA Analysis

SIDRA Analysis was completed by Arup for the proposed roundabout treatment at Searipple Road/Karratha Terrace. Queue lengths were investigated in the modelling analysis and the queue length anticipated for the Karratha Terrace approach is approximately 15m for the medium term scenario that was tested. The 15m queue length has minimal impact on the network at this location.

2.6 Comparison of treatments

The table below summarises and compares the two proposed treatments at the Karratha Terrace/Hedland Place intersection:

Table 1: Summary of Intersection Treatments

Design Item	Priority Control (all movements)	LILO	Preferred treatment
Sightlines	Appear to be substandard as a result of the curve radii for the roundabout treatment at Karratha Terrace/Searipple Road. Allowing all movements at this intersection may increase the risk of through/ right turn crashes.	Appear to be substandard. Reducing the turning movements to LILO will reduce the risk of intersection crashes.	LILO
Intersection spacing	Just meets the requirements highlighted in Liveable Neighbourhoods as the spacing between Hedland Place and Searipple Road is marginally more than 40m. Therefore impacting congestion on the network during peak times.	Just meets the requirements highlighted in Liveable Neighbourhoods as the spacing between Hedland Place and Searipple Road is marginally more than 40m. The reduction in turning movements to LILO will have less impact to potential congestion on the network during peak times.	LILO/Priority Controlled
Autotrack assessment	The right turn out for the design vehicle straddles the centreline treatment on Hedland Place, increasing the risk of side swipe collisions on Hedland Place. The design vehicle also overhangs the pedestrian footpath on the north/ west side of Searipple Road.	No right turn assessment required.	LILO
Pedestrian access	<ul style="list-style-type: none">There are two pedestrian crossings at the intersection. The crossing distance on the Hedland Place approach is approximately 23m. This is a long distance to travel for the elderly or a wheelchair user, without the provision of a pedestrian refuge.	<ul style="list-style-type: none">A pedestrian refuge is provided on Hedland Place to reduce the path of travel and to provide a safe resting space for the elderly and wheelchair users.	LILO

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Design Item	Priority Control (all movements)	LILO	Preferred treatment
	<ul style="list-style-type: none">Pedestrians will need to cross over two streams of traffic on the Karratha Terrace approach, therefore increasing the risk of pedestrian/vehicle conflicts.	<ul style="list-style-type: none">Pedestrians only have to observe one stream of traffic on the Karratha Terrace approach.	
SIDRA Analysis	No issues noted	No issues noted	Both

3 Recommendation

Arup considers that the LILO treatment is a more suitable and safe design for the Karratha Terrace/Hedland Place intersection in comparison to the all movements design based on the following items:

- Removes the risk of right/ through crashes at the intersection;
- Reduces potential congestion on the road network by restricting the turning movements to LILO;
- Safer ingress and egress for the design vehicle; and
- Reduces the crossing distance for pedestrians on the Hedland Place approach and complexity of pedestrian crossing of Karratha Terrace.

Nonetheless, there are options that can be considered to allow additional turning movements. However, as noted in the body of the note, each of these add complexity and conflict points to the intersection and increase the safety risk compared to the LILO. The possible options:

Option	Comments
1. Allow for a right turn only from Hedland Place to Karratha Terrace, in addition to the left in and left out.	This option still has similar limitations as described in the technical note above, but less conflict points due to banning right turn into Hedland Place.
2. Allow for a right turn only from Hedland Place to Karratha Terrace, and also ban the left turn out of Hedland Place	This is the preferred alternative to the LILO if additional movements are to be considered, but difficult to design/enforce turn restrictions which may lead to the same safety issues identified in the note for the all movements intersection.
3. Mini roundabout at Hedland Place and Karratha Terrace	Spacing not between Searipple Road roundabout not sufficient to develop approach geometry for roundabout. Roundabout could not be traversed by large vehicles (19 metre articulated vehicle) given the geometric constraints.

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4. Traffic signals at Hedland Place and Karratha Terrace	Traffic signals would not be approved by Main Roads WA at this location based engagement with Main Roads for the Searipple/Karratha Terrace intersection..
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When ranked in order of providing the improved road safety outcomes (from most safe to least safe):

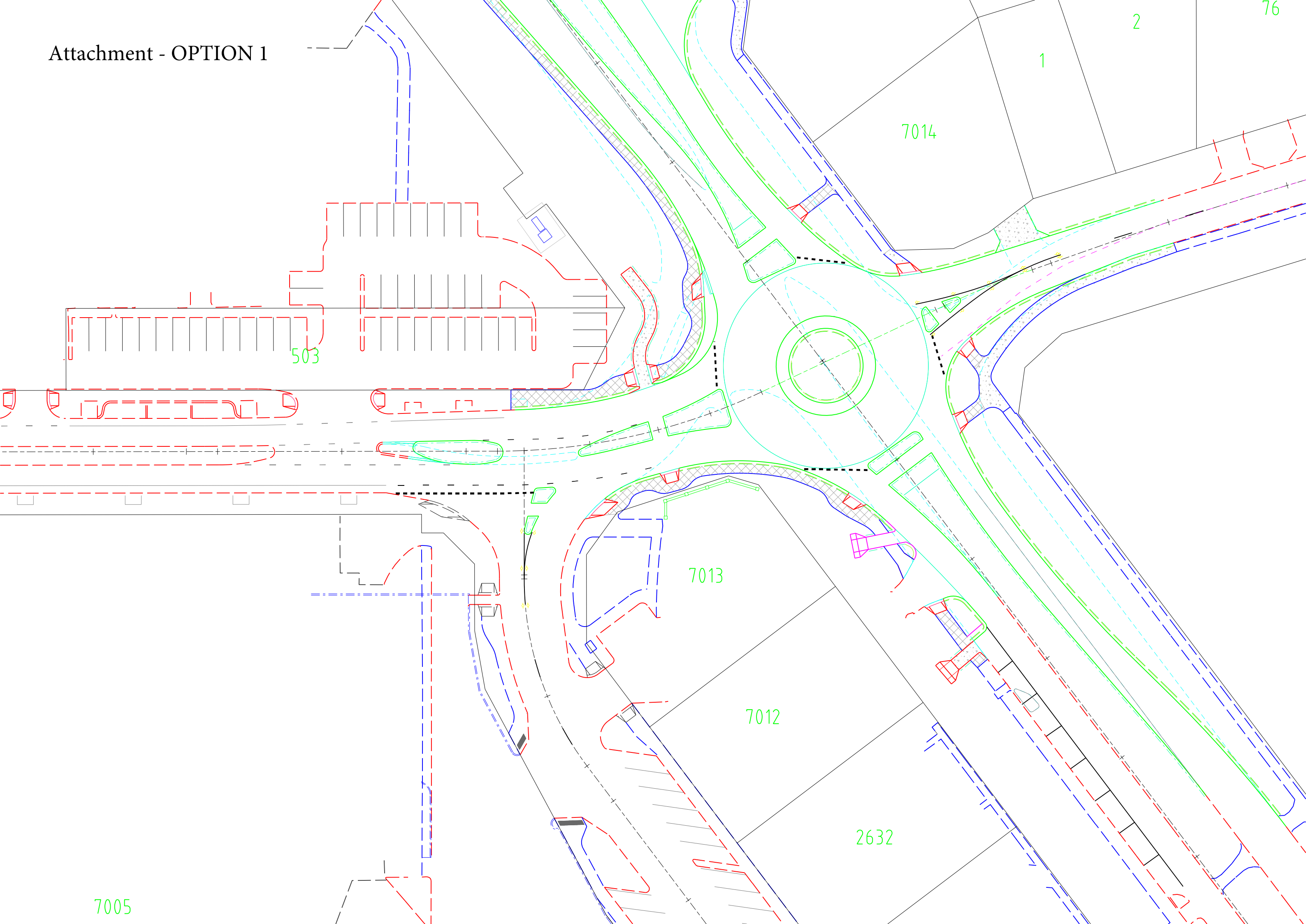
1. Preferred Option - Left in/Left out at Hedland Place
2. Option 2 – Allow for a right turn only from Hedland Place to Karratha Terrace, and also ban the left turn out of Hedland Place.
3. Option 1 - Allow for a right turn only from Hedland Place to Karratha Terrace, in addition to the left in and left out.
4. Option 3 - Mini roundabout at Hedland Place and Karratha Terrace (due to sight line limitations and vehicle tracking for 19metre articulated vehicle)
5. Option 4 - Traffic signals at Hedland Place and Karratha Terrace (due to limited approach distance)

It should also be reiterated, that enforcement of prohibited movements for options 1 and 2 is likely to prove difficult given vehicle paths (for small vehicles) do exist through the proposed traffic islands and the rural nature of the road network where users are used to full connectivity of the road network at intersections.

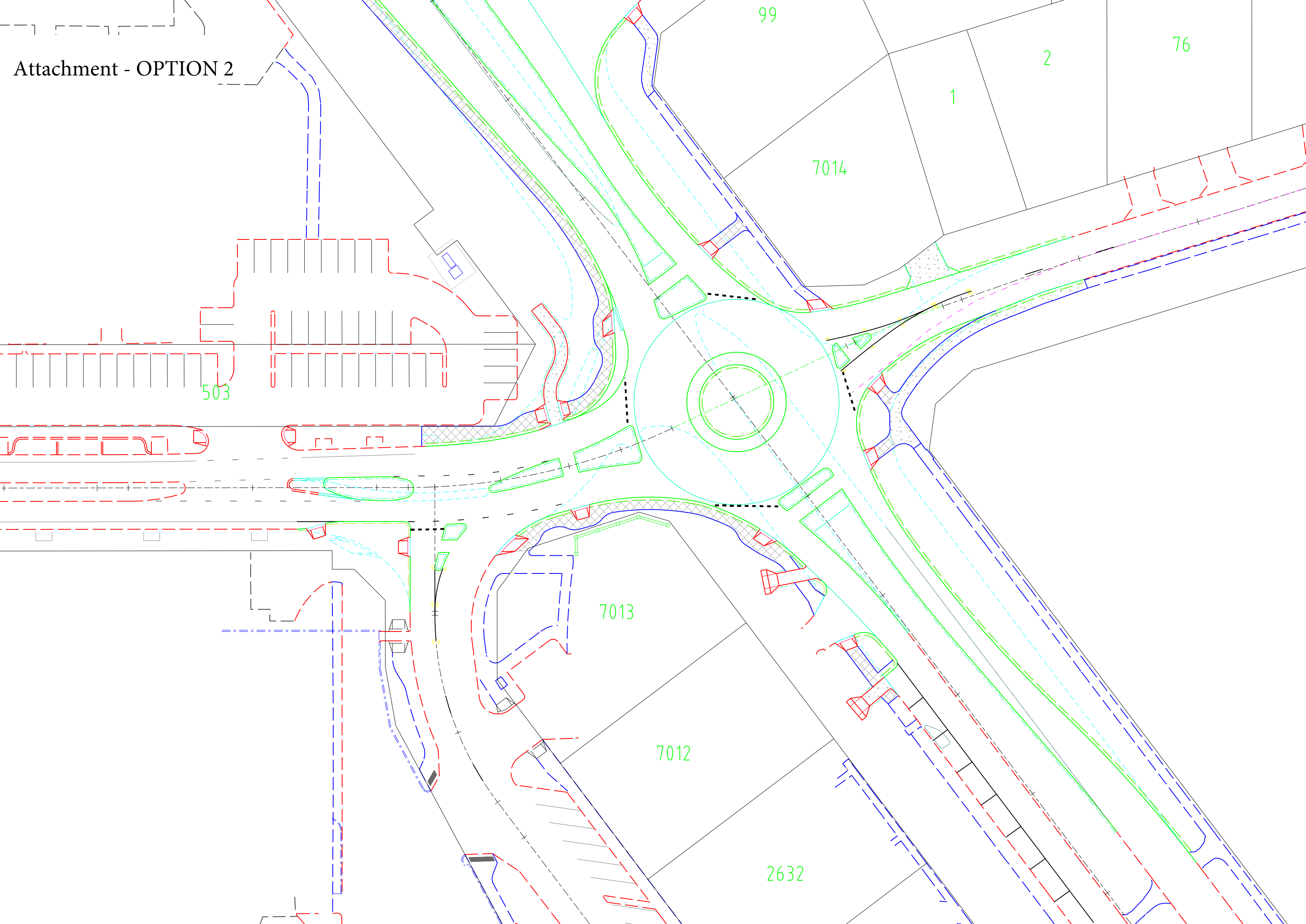
DOCUMENT CHECKING (not mandatory for File Note)

	Prepared by	Checked by	Approved by
Name	Catherine Deady	Darryl Patterson	Darryl Patterson
Signature			

Attachment - OPTION 1



Attachment - OPTION 2



Attachment - OPTION 3

